

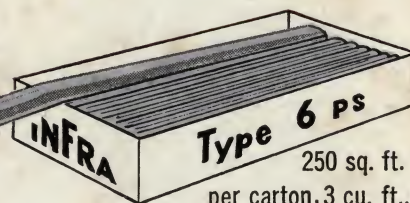
# HEAT FLOW BY **RADIATION** IN BUILDINGS

## SIMPLIFIED PHYSICS

by Alexander Schwartz, president, Infra Insulation Inc.

### MULTIPLE ACCORDION ALUMINUM

Full, uniform depth from joist-to-joist.\*  
Practically non-condensation forming.  
Storage space and handling drastically reduced.  
Low cost, lower fuel bills. More installed per man.  
Clean and sanitary. Does not retain odors.  
Lengths: 750', 500', 375', 188'.



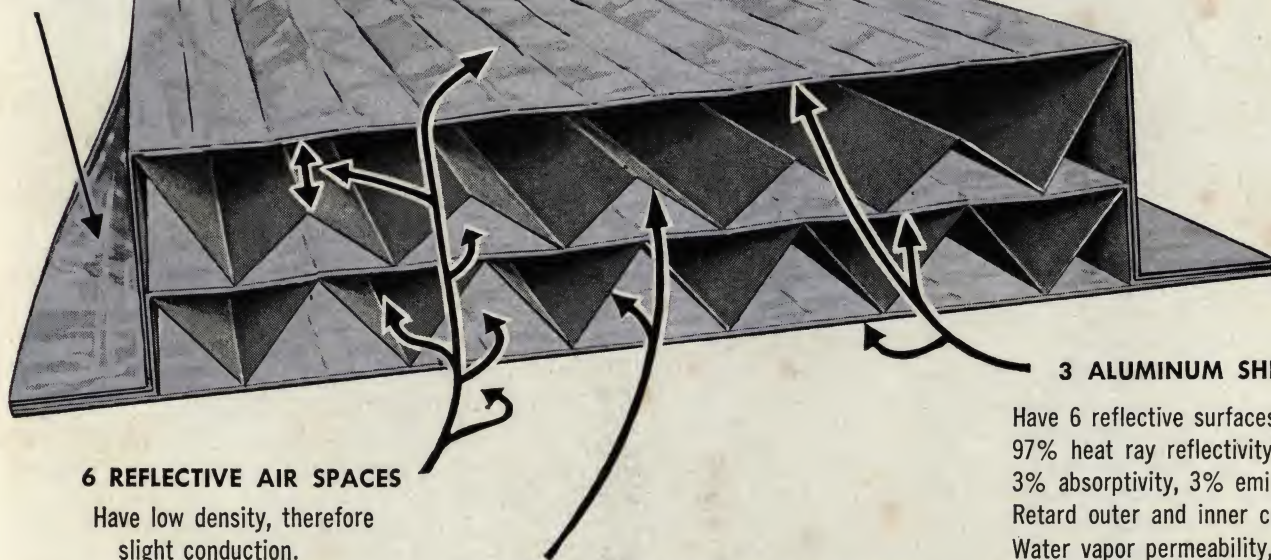
250 sq. ft.  
per carton, 3 cu. ft., 34 lbs.

(Ordinary insulation)  
(43 cu. ft., 250 lbs.)

## INFRA

*the Scientific Insulation*

STAPLING  
FLANGE



### 6 REFLECTIVE AIR SPACES

Have low density, therefore slight conduction.  
2 outer reflective spaces.  
4 rows of inner air spaces.  
Space above pleats 1" extra.

### ACCORDION SEPARATING PARTITIONS

Create 2 extra reflective spaces.  
Retard inner convection currents.  
Prevent aluminum touching aluminum.  
Available flame, mold, insect-resistant.  
Available with asbestos.

### 3 ALUMINUM SHEETS

Have 6 reflective surfaces each with 97% heat ray reflectivity, and 3% absorptivity, 3% emissivity.  
Retard outer and inner convection.  
Water vapor permeability, almost zero.  
1220° F. melting point.  
Permanent. Tough, special aluminum.  
Will not deteriorate. 99.4% pure.

### COST OF INFRA INSTALLED

in new construction between wood joists, material with labor.

Type 6PS about 10¢ sq. ft.  
Type 4PS about 8¢ sq. ft.

*Conserves winter fuel-  
promotes summer coolness*

(U. S. Patent Nos. 1,757,479; 1,890,418; 1,934,174; 2,015,817; 2,101,856.)

\*Patent applied for,



## INTRODUCTION

This manual is intended to give its readers a background in the subject of heat flow by radiation in building structures. The phenomena and principles involved, the laws of Nature which apply, are discussed in a *general* way. Although the material herein is often detailed and specific in *form*, it should be considered only as GENERAL information, not as a solution to any *specific* problem.

Convection and Conduction are also discussed, for they too play important parts in heat-flow; and will be treated even more exhaustively in a subsequent booklet.

The practical application to a *particular* building or to a *specific* problem of cooling, heating, vapor flow or condensation, of any subject discussed herein, cannot be determined by an inflexible printed page, nor safely undertaken by a non-expert.

It is a task for engineers and architects who have knowledge and experience in these particular fields. They can appraise the conflicting literature and its many ramifications, correlating and coordinating it with their own experience and knowledge. In addition, in order to properly evaluate the data in this or any other booklet and apply it to a specific case, such engineer or architect must study the MANY complex problems connected with the particular project, of which insulation is *only* ONE.

No booklet can replace the architect, the consulting engineer and their skilled associates, whose function it is to go out to the land site, inspect the ground, determine the amount of moisture in the ground, observe the atmospheric conditions, acquire a general picture of the heat and humidity conditions, etc.

### EACH PROJECT IS UNIQUE

Even experts can make final decisions and specifications only after they have carefully studied a project, including the occupants and their habits; the contents and function of the structure; the objectives sought; the combustion devices and other vapor-formers inside the building; proper ventilation; temperatures and humidities desired; type and details of building structure and equipment needed — and then only on the understanding that they must also supervise construction, installation and actual initial operation after occupancy.

The physician who diagnoses an illness or the attorney who considers a legal problem, may refer to books for stimulation, general information and relevant case histories; but he must carefully study the particular patient or problems, reach his own conclusions, make his own decisions. No book can do this for him. Nor are the cases of any two patients or clients exactly alike.

The consulting engineer or architect, when called upon to "prescribe" for a particular structure, can not refer to a book alone for the answer. Nevertheless this booklet should be immensely helpful even to a "non-expert," for it can supply him with much valuable information. The expert too, will find very useful data, which will refresh his knowledge of the

physics and mechanics involved, even though some of it may be controversial.

Each project is unique, a law unto itself. Circumstances and conditions are *never* identical. Each building is so different from every other building, even an adjoining one which seems to be identical; that in addition to the fact we do not encroach on the function of the architectural and engineering specialists who study, design and supervise a project and its operation, it would be impossible for any booklet to do so.

The insulation requirements of almost any two or more residences or cold storage houses for instance, will differ greatly from *each* other as well as from obviously different types of structures, such as farm buildings, schools, hospitals, etc. What may be suitable for one structure is often not applicable to the *very same type* structure *next door*. Too many variables may be present and must be considered.

### INSULATION NOT SELF-SUFFICIENT

The function of thermal insulation in *winter* is to help prevent excessive heat losses and vapor flow.

Implicit is the presence of heat; a well planned and properly constructed building; an adequate, properly operated and distributed heating system, of the proper kind and size, etc. Insulation *cannot create* heat. It can only retard the flow of heat and of vapor.

No amount of insulation, no matter how efficient and well-installed it may be, can sufficiently compensate for a heating system inadequate in size, construction, layout, etc.

The *summer* function of thermal insulation for residences, hospitals, schools, stores and other ordinary structures, and its function in air-conditioning and refrigeration, is to help prevent excessive heat and vapor from *entering* the structure.

While it is true that inadequate or badly installed insulation may sometimes hamper a good heating or cooling system in a well constructed building, the tail should not be expected to wag the dog, nor can it. It is simple enough to check whether the insulation has been properly installed in accordance with the manufacturer's instructions.

To achieve winter comfort at low fuel cost, it is necessary to have a properly constructed building, with an adequate heating system, with proper distribution of heat, PLUS *appropriate specifications* for scientifically adequate insulation. Similarly with summer conditions, air-conditioning, refrigeration, etc.

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The author of this booklet lectures extensively before many societies of architects and engineers; and before the faculties and student bodies of technological institutes of Engineering and Architecture the country over. His manual, "Simplified Physics of Vapor And Thermal Insulation" (now being revised, last edition was 1951), has been used as a text in scores of colleges and universities.



# NEWEST, DEEP-SPACED, ACCORDION INSULATION

## UNIFORMLY FULL DEPTH FROM JOIST-TO-JOIST

CONSERVES WINTER FUEL — REPELS SUMMER HEAT  
AIR CONDITIONING COSTS DRASTICALLY REDUCED

GIVES ENTIRE AREA BETWEEN JOISTS OR STUDS, MAXIMUM EDGE-TO-EDGE PROTECTION  
AGAINST HEAT LOSS AND CONDENSATION FORMATION

### NEW TYPE 6

*Uniform* in depth, and closely hugging the studs or joists to which its flanges are stapled, a new, improved form of aluminum insulation gives complete insulation coverage over the entire area it shields. The protection given by multiple sheets of accordion aluminum against condensation formation and heat flow now extends with full depth to the very edges of the joists. (Patent applied for.)

Another new and important *scientific* feature is an EXTRA-DEEP top inner *air space*.

Like its predecessors, this new form of multiple accordion aluminum is pre-fabricated to create *automatically* an insulation "blanket" of alternating layers of air, aluminum and fiber partitions in one installing operation. Its slight mass is capable of little heat storage.

The aluminum sheets are separated 1 $\frac{3}{4}$ " and 1 $\frac{1}{4}$ " apart by accordion fibrous partitions which make it impossible, regardless of sag, for aluminum to touch aluminum with resulting conduction. The inner layers of air spaces created by these partitions are large, have low density, and therefore slight conduction.

### 22 WAY PROTECTION

(1) The aluminum surfaces have a very high heat-ray reflectivity of 97%;

(2) heat-ray absorptivity of only 3%;

(3) and only 3% heat-ray emissivity.

(4) The sheets of aluminum and fiber retard outer and inner convection; and

(5) create large multiple air spaces. Large air spaces have low density and therefore slight conduction.

(6) These aluminum sheets have almost zero permeability and are practically impervious to the flow of vapor, warm air and cold air. Vapor infiltration under the flat, stapled flanges is slight. Each external aluminum sheet on *both* sides of the insulation is a genuine vapor barrier against vapor flow from inside or outside the building; a technique which is not feasible with some insulations.

(7) Each pound of water vapor which flows out of a building in winter represents a loss of 1060 BTU's of heat and the cost of the fuel consumed to help produce that vapor.

(8) Each aluminum sheet is *continuous*, from 375 to 750 feet long. Many ordinary insulations are made in short, 4 ft. lengths, and thus have "breaks" every 4 feet.

(9) The efficiency of Infra Insulation causes substantial economies in the size and cost of the furnace or heating equipment needed to heat a building, and also reduces fuel consumption costs.

(10) The costs of installing and operating air-conditioning equipment are drastically reduced by Infra, and comfort is increased.

(11) The building which is not artificially cooled in summer needs this shield against radiant heat even more, for Infra often helps keep structures considerably cooler than the shade outdoors.

### CONDENSATION FORMATION MINIMIZED

(12) The scientific construction of multiple layers of accordion aluminum, fiber and air spaces, and the nature and properties of the component materials, so minimize condensation formation on or within this insulation that it is practically non-condensation forming.

(13) Because of Infra's virtual zero permeability, as vapor pressures develop inside wall and roof spaces, fortuitous vapor and water (for instance rain), will gradually flow out as vapor through non-metallic exteriors, because vapor flows from areas of greater to areas of less vapor density. The vapor is unable to back up through the aluminum, so it flows out through exterior walls and roofs because their permeability to vapor in comparison with that of metal is greater than the customarily required 5 to 1 ratio.

(14) By minimizing condensation formation, Infra Insulation reduces the hazards of timber rot, peeling paint, crumbling plaster, masonry and mortar deterioration, the rusting of iron and steel.

### FLAME, MOLD AND INSECT RESISTANT

(15) Its aluminum sheets cannot burn, and have a melting point of 1220° F. Their low emissivity of only 3% reduces the hazard of fire spreading on the side away from a fire; in contrast with ordinary materials with their 90% emissivity, which radiate considerably more heat into surrounding areas, causing them and their contents to dry up more quickly, and be more susceptible to rapid combustion and conflagration.

(16) Infra aluminum is tough, many times tougher than the .0004" to .0005" thin metal commonly used. The exposed surfaces of Infra have bursting strengths up to 154 lbs. per sq. inch, and tearing strengths up to 335 grams. The commonly used thinner aluminum foils have less than 3 lbs. bursting strength and less than 10 grams tearing strength.

(17) *Each* of Infra's accordion aluminum sheets extends not only from joist to joist, but with uniform, full depth.

(18) Infra insulations are clean, sanitary, and easy as well as inexpensive to install.

(19) They are available with flame, mold and insect resistant separating fibers.

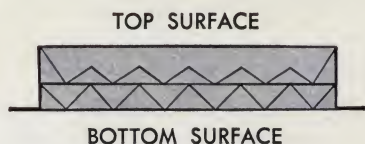
(20) Also available with ASBESTOS fiber separators, to meet *very strict fire* regulations.

(21) Because Infra Insulation is so *lightweight* (about 1 oz. to the square foot), and also because its exposed metal sheets *do not absorb moisture*, routine stapling will suffice to keep it in place permanently even in damp crawl spaces. There is no need for expensive supports made of wire, lath strips, furring, backer-board, etc., so often required with many ordinary insulations.

(22) Leading architects and builders throughout the country have continuously and repeatedly specified and used over 300 MILLION SQUARE FEET of Infra in their projects during the past ten years.



# INSTALLATION TECHNIQUES



When opened, one outer surface is the **BOTTOM** surface. The **TOP** surface is parallel to it and vertical at its ends. (*Patent applied for.*)

Infra Insulation is installed in ceilings, walls and floors; between wood beams and studs, between steel girders, trusses; under concrete floors; under and over radiant heating panels, etc. Any handy man can install Infra, for it requires no special skill. At first the mechanic should work slowly to gain experience. After a few days he should be able to install a substantial amount daily.

Sagging is harmless, perhaps beneficial, except if it results in contact, which eliminates part or all of *one* reflective space. At the *points* of contact *only*, that particular surface of aluminum loses insulation value. The rest of that surface, and all other surfaces and spaces, are unaffected.

To reduce sag, install with **BOTTOM** surface facing down. Use **BOTTOM** surface for exposures — it's *tougher*.

This insulation has 1½" flanges which are stapled high above the bottom of the beam when attached from below, to prevent any sag from touching lath or ceiling board.

Where the space will be enclosed both sides, install the insulation about midway on the beam. This provides **TWO** additional reflective spaces, one on each side of the insulation, which increases thermal efficiency. The upper and lower surfaces of the insulation should be spaced *not less than* ¾" from floor *above*, if any; and from lath or wall board *beneath*, if any. Smaller spaces are also effective, but decreasingly so.

Larger spaces improve insulation efficiency in *up* and *down* heat flow. Where insulation is permanently exposed to a large open space on one side, as in exposed ceilings, floors and crawl spaces, install so the *enclosed* space will be as large as possible.

For less than 12", 16", 20" or 24" centers, fold one or more accordion pleats against the flange when stapling.

For wider than 24" centers, see page 6, "For Wide Spaces."

**TOOLS:** For cutting or fitting, use snips or heavy shears. The use of an automatic stapling tool makes for low cost installation. For the *occasional* applicator we recommend the tacker; for the specialist, the stapling hammer with a *recessed driver*. (*We can furnish stapling tools, staples, cardboard strips and asbestos strips.*)

*It is best that each mechanic work ALONE, by himself.*

## FOR WOOD BEAMS

1. **CEILINGS:** Without measuring length, without opening the insulation except for one flange, place insulation against joist, with opened flange pointing down, with **BOTTOM** side and mass facing **OUTWARD**. *Illustration No. 1.* The next step in the case of most Infra types is to pull or push the *small edge pleat* open, so as to also expose the *top* portion of the opened flange for stapling, *Illustration No. 1.*

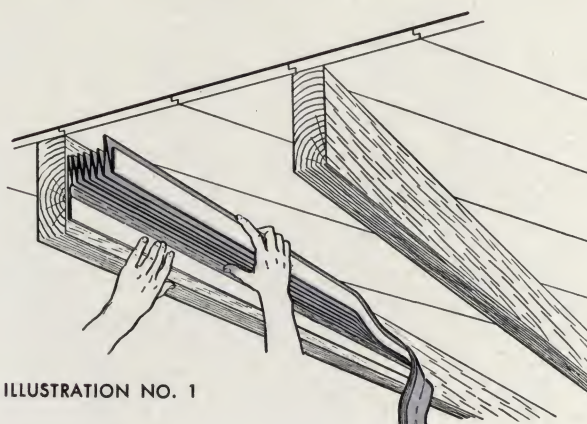


ILLUSTRATION NO. 1

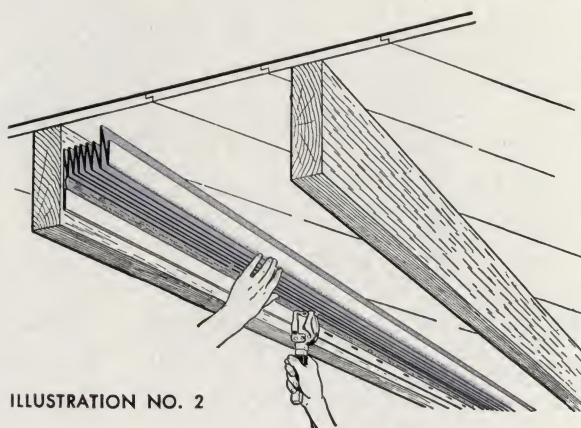


ILLUSTRATION NO. 2

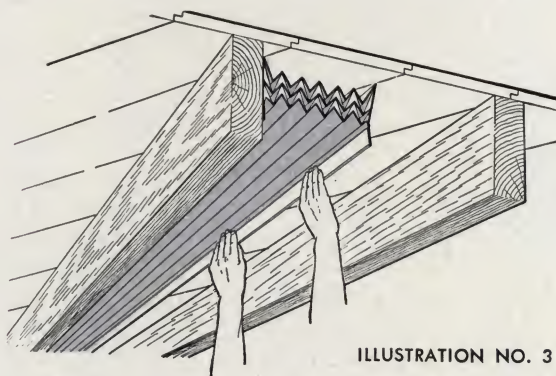


ILLUSTRATION NO. 3

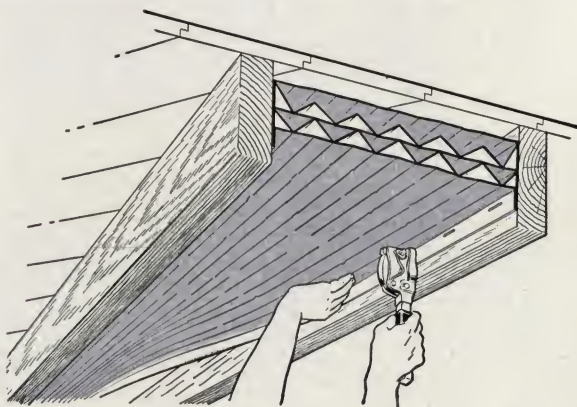


ILLUSTRATION NO. 4



For the entire length of the ceiling beam, staple into the flange as high as possible, so that the insulation will hug the joists more closely. *Illustration No. 2.* Only then cut it off.

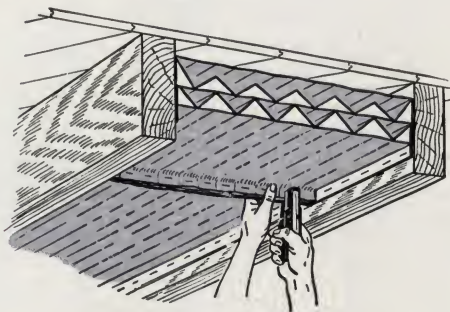
Staple flange CLOSELY, about every 3" or 4" or closer, thus minimizing air, vapor, and heat infiltration under flanges. (For special conditions requiring extra tight stapling, we furnish cardboard strips or asbestos strips. Cardboard strips cost only 1¢ for 2½ lineal feet.) A perfect vapor seal with metallic tapes is generally not essential except for extreme conditions such as refrigeration, etc.

2. After the entire length of one flange has been stapled, the unstapled flange is grasped at one end by BOTH hands (hands stretched 3' apart), and pulled open. *Illustration No. 3.* This prevents tearing, and provides opportunity for ample stapling. Continue pulling open and stapling the 2nd flange about 3' at a time until opposite beam is also completely stapled.

When stapling the second flange, one hand should push the surface of the insulation away from the flange, to make room for hammer swing. *See Illustration page 4.*

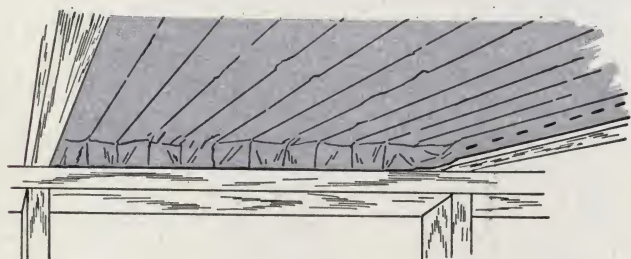
When a strip of insulation ENDS somewhere along the ceiling or wall, and a new strip is to be connected, a good procedure is to BEND 2" to 3" of the end of first strip. Then open a few feet of the 2nd strip and BEND 2" to 3" of its end. Staple both bent ends together with a Bostitch P-6 stapling plier or similar device. *See Illustration below.*

Another acceptable method: — Butt ends together. Staple piece of aluminum about 12" long across entire width of insulation, 6" on either side of joint, with Bostitch T5-8 Outward Clench Tacker. For neatness, staple close to edges of attached piece. *See Fig. 6, page 11.*



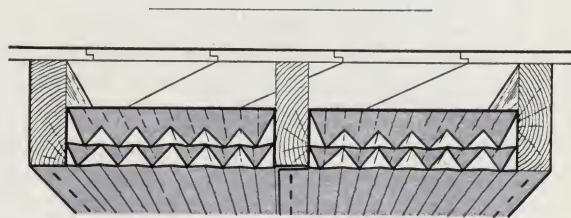
**BRIDGING:** Insulation can be installed under, over or through bridging.

**WHEN TO INSTALL:** Install insulation *after* ELECTRIC WIRING is in place and inspected. *Caution:* In winter and autumn, be sure windows and doors are in place as a protection against winds.



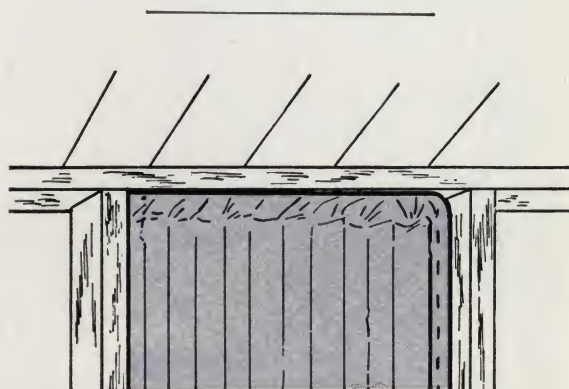
CEILING insulation should be extended at both ends about 2" or 3" and tucked at right angles onto the WALL. *See illustration above.* Nothing elaborate, but tuck it close.

**TEARS:** Place over torn area a piece of aluminum wide enough to reach well onto both joists for permanent *stapling* to them, and long enough to extend 6" beyond *each* end of the tear. (When a Bostitch T 5-8 Outward Clench Tacker is available, the ends of the aluminum piece can also be easily fastened to the bottom sheet of the insulation with ½" staples. *See Page 11, Fig. 6.*)

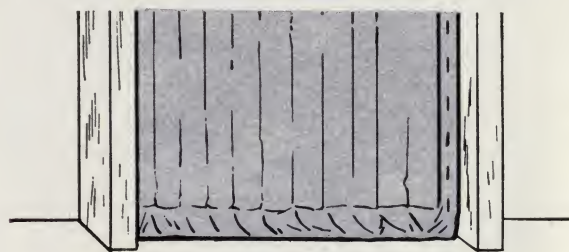


The insulation CAN be stapled to the FACE of the joists, top or bottom, where it will nevertheless be *exposed* to an air space, as often occurs in attic rafters, floors, crawl spaces, factory ceilings, auditoriums, etc.

It may sometimes be inadvisable to install this way if a finish material such as lath or wallboard is to be applied directly to the framing, and will contact the lower aluminum surface. This would reduce insulation value by eliminating one space, which in itself may not be serious. But with the entire joist exposed in winter to the cold air space above the insulation, the portion of the ceiling directly beneath the joist might be colder than the rest of the ceiling, and cause areas of uneven temperature. This might sometimes cause visible lines or dust streaks on the ceilings or walls.



**WALLS:** Extend the insulation about 2" or 3", and staple or tuck at right angles on to ceiling and floor, nothing elaborate. This is easier if the BOTTOM side faces the room. With Type 2 the ALUMINUM should face the warm side.



**CRAWL SPACES:** Do not proceed until flooring is finished, otherwise objects may fall on insulation.

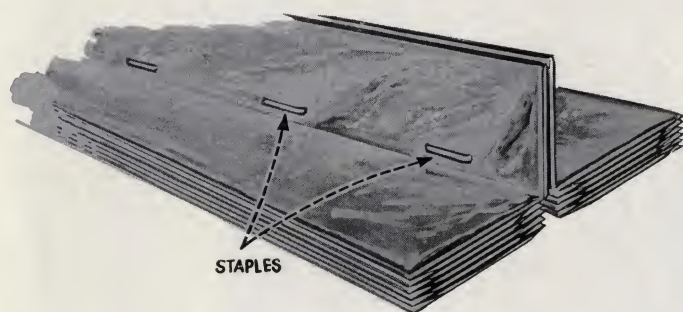
**RADIATORS:** Place Infra "Retardive" Insulation back of recessed radiators. (*See page 8 for instructions.*)

**PAINTING:** In winter, it is preferable not to paint *ceilings* until they are dry.



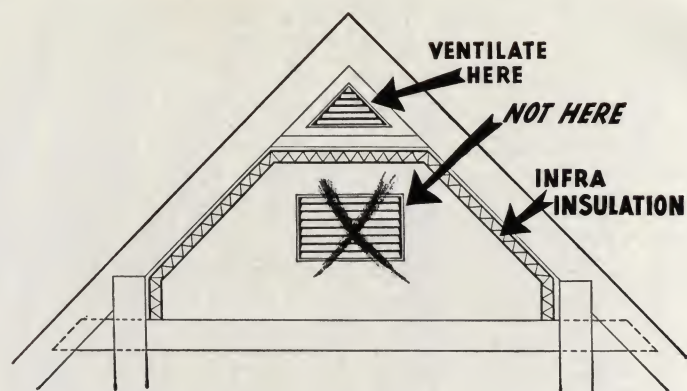
**DAMP CELLAR WALLS:** Moisture and condensation problems can be alleviated by installing Type 6, Type 4, or Type 4 Jr. Condensation is often mistaken for water seepage.

**FOR WIDE SPACES:** (1) Use as many full-length strips of the necessary combination of widths of Infra Insulation as will equal or be wider than the required dimension. (2) The floor is a good place to lay them and work from. (3) Without expanding Infra or opening the accordion pleats, staple the required strips flange-to-flange. An easy technique which maintains efficient thermal values in the flange area is to butt two or more unopened strips together, flange edges facing up together, and staple down deep, as close as possible to the bodies of the insulation strips. *See Illustration below.* (An appropriate tool is the P-6 Bostitch stapling plier which we can furnish.) Then install like a single strip.



**ELECTRIC OUTLETS:** When necessary, cut a hole in the insulation slightly smaller than the outlet, and tuck the insulation around it tight and snug. *See Illustration below.*

**PIPES:** Where the Insulation does not clear, it should be notched around the pipes. *See Illustration below.*



IF ROOF RAFTERS or ATTICS are insulated, it is better practice to cap under the ridge, insulate across, and ventilate ABOVE, never below. It is essential with slate roofs.

Don't vent below insulation. It lets heated air out, cold air in, wastes fuel in winter. This defeats the purpose of insulation, which is to prevent the escape of heat.

VENTILATION is generally desirable above all insulations, especially for those without adequate vapor barriers, and more so in buildings where crowds or other conditions create large amounts of water vapor. Purdue University, in booklet "Moisture Problems in Homes," Extension Series No. 70, page 33, recommends at least 1 sq. in. of free opening for each 4 sq. ft. of ceiling and wall surface exposed to vapor flow, and says no point in the vented space should be more than 25 ft. from a vent opening. Adequate ventilation takes care of vapor which seeps through into a building space from within, and of evaporated water which leaks in through nail holes and other openings from without. In summer, attic vents help lessen the heat load imposed by the sun.

UNVENTILATED JOIST SPACES, particularly in flat roofs, can sometimes be vented by cross-furring above the roof joists, or by boring holes horizontally through the joists, at the neutral axis. This provides for some circulation of air and vapor above the insulation between adjacent joist spaces when it is impractical to vent each separate space.

**VAPOR:** During construction and sometimes for months after, the water in the plaster and masonry continues to evaporate. Salamanders and other combustion equipment also create quantities of vapor. Condensation problems can be diminished by keeping windows open. In winter, for wind stops use muslin, or paper which is porous to vapor.

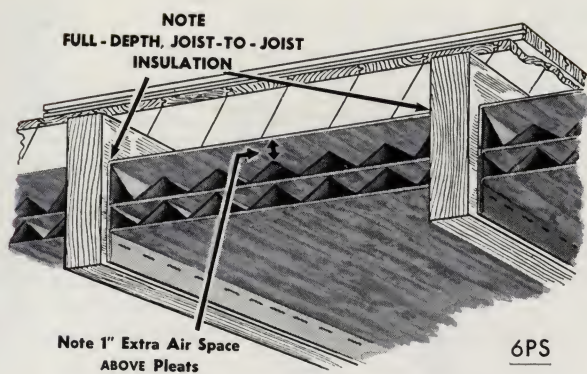
**TABLE OF STRENGTHS**

| ALUMINUM<br>FOILS<br>(thickness) | BURSTING<br>STRENGTH<br>(Mullen Test) | TEARING<br>STRENGTH<br>(Elmendorf Test) |
|----------------------------------|---------------------------------------|-----------------------------------------|
| .0005"                           | 3 lbs. sq. inch                       | 10 grams                                |
| .00065"                          | 10 lbs. sq. inch                      | 14 grams                                |
| .0007"                           | 12 lbs. sq. inch                      | 16 grams                                |
| .0008"                           | 15 lbs. sq. inch                      | 20 grams                                |
| .0009"                           | 17 lbs. sq. inch                      | 28 grams                                |
| .001"                            | 20 lbs. sq. inch                      | 35 grams                                |
| .0015"                           | 28 lbs. sq. inch                      | 64 grams                                |
| .002"                            | 52 lbs. sq. inch                      | 80 grams                                |
| .005"                            | 154 lbs. sq. inch                     | 335 grams                               |

PERMEABILITY to water-vapor of aluminum of .00065" and greater thickness is almost zero.



# TYPE 6



Best for ceilings, roof spaces, crawl spaces, ducts, cold storage, air-conditioning.

Cost of Type 6PS in new construction, between wood joists, material with labor, should be about 10¢ per sq. ft.

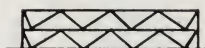
Type 6PS: (*pleated, standard.*) Edge-to-edge, full uniform depth insulation. 3 tough, continuous aluminum sheets; SIX reflective surfaces; SIX large reflective air spaces (2 outer and 4 inner). Center aluminum sheet is separated 1 $\frac{3}{4}$ " from top aluminum, and 1 $\frac{1}{4}$ " from bottom aluminum, with 1" extra air space ABOVE pleats. 2 flame, mold and insect resistant accordion fiber partitions. BOTTOM aluminum .0009" thick; top aluminum .0008". For 16", 24" centers. Cartons contain 250 sq. ft., all 1 continuous strip. Occupy 4 cu. ft., 36" x 22" x 9"; weight 35 lbs.

6PSH: (*heavy.*) Similar to Type 6PS except BOTTOM aluminum is .002" thick; top sheet .001" thick; or both sheets made of 3-ply laminate. Usually used where either surface is exposed. 1¢ sq. ft. more than Type 6PS. Cartons 250 sq. ft., all 1 continuous strip. For 16", 24" centers.

6PSe, 6PSHe: (*exposed flange.*) Same as 6PS and 6PSH except metal on flanges is exposed. For 16" and 24" centers. Made to order.

6PSHw: (*wide.*) Same as 6PSH-24" except 1 $\frac{3}{4}$ " wider. For steel beams, trusses, etc. Cartons 250 sq. ft., all 1 strip.

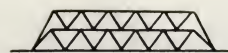
6PSt: (*thinner.*) Same as 6PS except aluminum is not quite as thick, and separating fibers are not flame, mold and insect resistant. Made only to order to meet competition of insulations which use extremely thin aluminum and non-flame resistant paper.



6PK: Same as edge-to-edge 6PS, with .0009" thick BOTTOM aluminum; except that all 3 aluminum sheets are separated 1 $\frac{1}{4}$ " from each other, and TOP aluminum is .0007" thick. 16", 24". Cartons 500 sq. ft., occupy 3 cu. ft., weigh 45 lbs. Cost, material with labor about 9¢ sq. ft.

6PKh: Same as 6PK, except BOTTOM aluminum is .002", TOP .001", or both 3-ply laminate. Used where either surface is to remain exposed. For 16", 24" centers.

6PKt: Same as 6PSt, except that all 3 sheets of aluminum are separated 1 $\frac{1}{4}$ " from each other. Made only to order.



6AP: (ASBESTOS) 3 tough, continuous aluminum sheets, 6 reflective surfaces, 6 reflective spaces (2 outer and 4 inner). 2 asbestos accordion separating partitions. Trapezoid in shape. Carton 250 sq. ft., all 1 strip. For 16" centers. About 14¢ per sq. ft. (*Also available in Type 4 as 4AP.*)

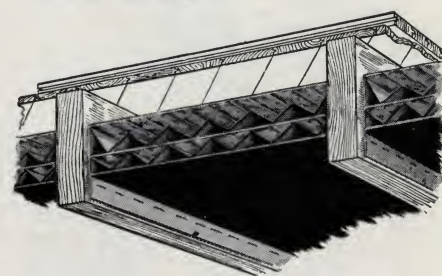
6PC: Same as 6AP, except separating partitions are flame, mold and insect resistant fiber. For 12", 16", 20", 24" centers.

6PCt: Same as 6PC except aluminum is not quite as thick, and separating fibers are not flame, mold and insect resistant. Made only to order, to meet competition of insulations which use extremely thin aluminum and non-flame resistant paper.

6PCmf: Used where exposed aluminum is not wanted. Similar to 6PC except BOTTOM surface is flame, mold and insect resistant fiber; nearest accordion partition is thick aluminum. 16". Cartons 250 sq. ft., all 1 strip. To order.

## TYPE 6PSHb

Cost between  
wood joists,  
insulation with  
labor, about  
15¢ per sq. ft.



Type 6PSHb: (*black.*) Same as Type 6PSH except that the exposed BOTTOM aluminum surface has an emissivity of over 90% because it is lacquered almost black. For 16" and 24" centers. Cartons 250 sq. ft., all 1 strip. Made to order.

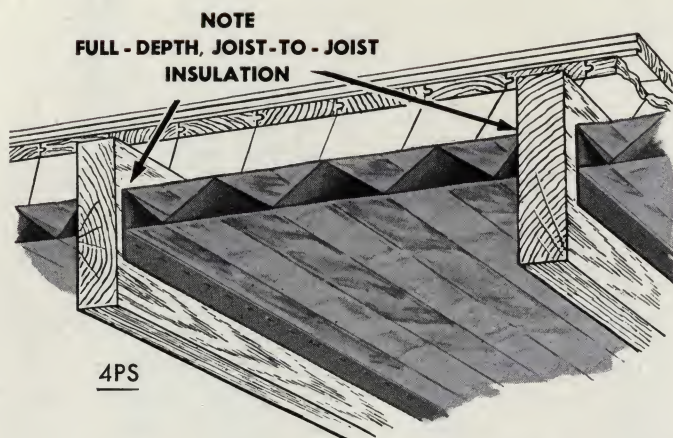
Some makers of exposed radiant heating coils whose equipment causes convection flow upwards in ceiling spaces which develop temperatures in excess of 150° F., recommend the use of Type 6PSHb. Their theory is that under such circumstances the upper surface of the ceiling below the insulation is cooler than the undersurface of the insulation itself, which has been heated by conduction through contact with the convected hot air rising from the coils. Since radiant flow is from a warmer surface to a cooler surface in any direction, there will be a flow of heat rays downward from the bottom, black lacquered surface of the insulation with its 90% emissivity, to the cooler ceiling below it. The other unlacquered aluminum surfaces however, with their low 3% emissivity and high 97% reflectivity, will continue to retard the flow of heat upward.

(If the ceiling surface below were warmer, heat ray flow would be upward, and it would be better to use an unlacquered aluminum surface at the bottom of the insulation, with its high, 97% reflectivity, because in that case the need would be to reflect back the UP flowing heat rays.)

*Infra Insulation Inc. reserves the right, without further notice, to use thicker or thinner metal for any insulation than herein described. (There is no relationship between thickness of aluminum sheets, and their reflectivity, absorptivity and emissivity.) Instead of just aluminum sheets, an EXTRA TOUGH 3-ply laminate made of strong non-treated paper between 2 sheets of aluminum, may be used.*



## TYPE 4



Popular for ceilings and under floors. The best and driest for wall spaces.

Cost of Type 4PS in new construction, between wood joists, material with labor, should be under 8¢ per sq. ft.

Type 4PS: (*standard.*) Edge-to-edge full depth insulation. 2 tough, continuous, aluminum sheets, separated 1¼" apart. FOUR 97% heat-ray reflective surfaces. FOUR reflective spaces, 2 outer and 2 inner rows. Separating accordion partition of flame, mold and insect resistant fiber. BOTTOM aluminum .0009" thick, TOP .0007". For 16", 24" centers. Carton 1000 sq. ft., all 1 continuous strip, 2½ cu. ft., 36" x 22" x 5½", weighs 55 lbs. Also 250 sq. ft. cartons.

4PSH: (*heavy.*) Edge-to-edge full depth insulation. Used where either surface is to remain exposed. BOTTOM aluminum

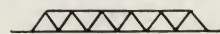
.002" thick; TOP .001"; or both made of extra tough, 3-ply laminate. 16", 24". Costs about 1¢ sq. ft. more than 4 PS. Carton 1000 sq. ft., all 1 strip.

4PSe, 4PShe: Same as 4PS and 4PSH, except metal on flanges is exposed. 16", 24". Made to order.

4PSHw: Same as 4PSH 24" except 1¾" wider. Used with steel trusses, steel beams, etc. Cartons 1000 sq. ft., all 1 strip.

4PSt: (*thinner.*) Same as 4PS except aluminum is not quite as thick, and separating fiber is not flame, mold and insect retardant. Made only to order, to meet competition of insulations which use extremely thin aluminum and non-flame resistant paper.

4PS-PLUS: Same as 6PS minus TOP metal. Has 1 air space more than 4PS. 16", 24". Carton 500 sq. ft., all 1 strip.



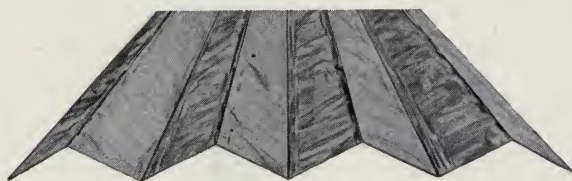
4AP: (ASBESTOS) 2 tough, continuous aluminum sheets, 4 reflective surfaces, 4 reflective spaces (2 outer and 2 inner). Asbestos accordion separating partition. Trapezoid in shape. For 16" centers. Carton 500 sq. ft., all 1 strip. Cost about 9¢ per sq. ft. (*Also available in Type 6 as 6AP.*)

4PC: Same as 4AP except partition is flame, mold and insect resistant fiber. For 12", 16", 20" and 24" centers.

4PC-PLUS: Same as 6PC minus TOP metal. Has one space more than Type 4PC. 16", 24". Carton 500 sq. ft.

4PCt: (*thinner.*) Same as 4PC except aluminum is not quite as thick, and separating accordion fiber is not flame, mold and insect resistant. Made only to order, to meet competition of insulations which use extremely thin foil and non-flame-resistant paper.

## RETARDIVE



The economical insulation.

Cost in crawl spaces and walls, material with labor, should be about 5¢ sq. ft.

For 16", 24" centers. Fits ½" or ANY deeper space. Extra tough, untreated fiber, laminated between 2 aluminum sheets. Has high 97% reflectivity, and only 3% emissivity; therefore retards secondary ignition on side away from fire. ACCORDION shape, 1 strip 750' long, 1000 sq. ft. in a carton 2/3 cu. ft. Weight 30 lbs.

RADIATORS. Retardive reflects back much of the radiant heat otherwise lost through outer walls by absorption, conduction and subsequent convection and radiation.

### HOW TO INSTALL GENERALLY

RETARDIVE has tough, fibrous flanges for easy stapling and low installation labor costs. For best results, install with an air space facing both surfaces. If attached to face of furring, run finger down edges to indent for an air space.

### HOW TO INSTALL BEHIND RADIATORS

Where an enclosure is 30" high and 40" long, 2 strips of 24" Retardive Insulation will be required.

1. With insulation *unopened*, snip off pieces about 6" longer than height of enclosure, in this case 36" pieces.

2. Staple one flange of unopened Infra to face of furring at end of enclosure. Bend insulation 3" top and bottom at right angles. Run finger along edges to indent for air spaces.

3. Attach to the wall, vertically, lath or furring about the height of enclosure. Staple the Insulation to it. (If expedient, first attach the furring to the flange, then fasten to wall.)

4. Attach 2nd piece of Insulation to opposite end furring of enclosure back. Staple to center wood strip.

MASONRY WALLS: Sometimes lath strips cannot be used. After nailing and caulking, cement Retardive to wall. This forms *one* efficient reflective insulating space and surface.

### FLAT RETARDIVE

For water and vapor-proofing, insulating, wind-breaking.

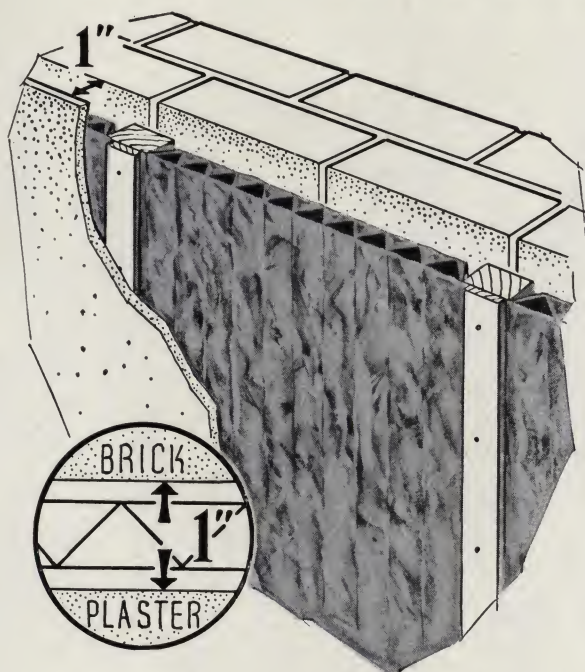
ALL-METAL, .0015" thick aluminum. Widths: 17⅜", 36". Weight 21 lbs. 1000 sq. ft. per roll.

3-ply S: (*Standard*), tough untreated fiber, laminated between 2 aluminum sheets. 17⅜", 36". Weight 25 lbs. 1000 sq. ft. per roll.

3-ply Sh: Same as 3-ply S, except fiber is *extra* thick, extra tough. 17⅜", 36". Weight 36 lbs. 1000 sq. ft. per roll.



## How to Insulate Masonry Walls



Convert basements and other areas with masonry walls, to active use for playrooms, storage, laundries, workshops, even living-quarters. Create comfortable, insulated areas in factories, warehouses, piers, terminals, garages, etc., by insulating against *dampness* and *heat loss*.

### TYPE 4 Jr.

$\frac{1}{2}$ " DEEP

#### For Walls of

Brick, stone, concrete, cinder or cement blocks

Create 1" Wall Space —  
Get 2" Dry Insulation Value

at 8¢ sq. ft., insulation with labor

#### A MUST FOR SHALLOW SPACES

|              |                     |                   |
|--------------|---------------------|-------------------|
| cellar walls | air ducts           | cold storage bins |
| floor panels | floors              | heated trucks     |
| airplanes    | ships               | pre-fab bldgs.    |
| r. r. trains | trailers            | freight cars      |
|              | refrigerated trucks |                   |

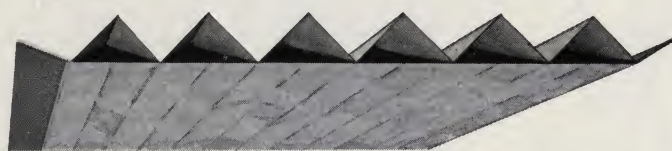
#### HOW TO INSTALL

Follow general instructions. To *face* of 1" furring strips attached to walls on 16" centers, *tack* flange of Type 4 Jr. with an occasional staple, *BOTTOM* surface facing room. Expand insulation and tack to *face* of adjacent furring strip. Lap and tack flange of next piece of insulation *over* tacked flange of adjacent installed insulation. Then nail rough lattice strip over combined flanges. This prevents contact with lath or wallboard which is subsequently attached, and creates an additional air-space.

TYPE 4 Jr.: 2 tough, continuous, ALUMINUM SHEETS, permanently separated  $\frac{1}{2}$ " APART by an accordion partition of flame, mold and insect resistant fiber. FOUR reflective surfaces. FOUR reflective air-spaces, 2 outer rows and 2 inner rows. For 16" centers. Cartons 500 sq. ft., all 1 continuous strip.

TYPE 4A Jr.: (asbestos.) Same as 4 Jr. except accordion fiber partition is ASBESTOS. Cartons 500 sq. ft.

## TYPE 2



An economical insulation. Used in walls and crawl spaces.

Costs about 5¢ sq. ft. material with labor.

2PS: (standard.) 2 reflective spaces and 1 non-reflective. One sheet aluminum. Flame, mold and insect resistant accordion fiber. 12", 16" and 24" widths. Carton 1000 sq. ft., all 1 strip.

2Pc: (crawl spaces.) Same as 2PS except accordion fiber is asphalt impregnated, waterproofed kraft instead of flame resistant fiber. Used in crawl spaces. *For best thermal results, asphalt kraft should face downwards, and hang loose.*



# STEEL BEAMS AND TRUSSES

In Factories, Warehouses, Residences, Stores, Hospitals, Theatres, Markets, Arenas, Schools, Hangars, Gymnasiums.

Steel beams are good conductors, extract much heat from surrounding atmosphere, causing condensation which at times drips. They need appropriate insulation against heat flow, vapor flow and condensation formation.

There is no necessity in winter to heat up TONS of steel beams and some insulations, which emit heat rays at a 90% rate on the cold side. In summer, iron and steel beams, some insulations, and most building materials, tend to continue to radiate uncomfortable heat into a room for some time after the outside air has cooled. Scientific Infra, multiple aluminum sheets not only are cooler at night, but also all through the hot summer day, generally maintaining temperatures considerably cooler than the shade outside. Infra can be installed in *long continuous lengths up to 750 feet.*

## HOW TO INSTALL INFRA BETWEEN OPEN WEB STEEL BAR JOISTS

The following are two suggested methods for installation which have been successfully used. Other methods have also been successful. For this work a Bostitch P-6 Stapling Plier or equivalent tool is recommended.

The first method will be illustrated with 24" oc (on center) joist spacing, and the second method will be illustrated with 30" oc (on center) spacing. *For other spacing, either method or a combination of both methods may be used.*

**BASIC INSTRUCTIONS:** Read paragraphs on pages 4, 5, 6 under heading "Installation Techniques," with particular emphasis on paragraph entitled "FOR WIDE SPACES" with illustration on page 6.

(A) Place a strip of Infra Insulation on the *inner* side of the first bar joist, without opening the insulation except for one *flange* opened and pointing down, with **BOTTOM** side and **MASS** facing **OUT**. Staple that one flange to an Infra card-board or asbestos starter strip placed on the outer side of the same first bar joist. *See Fig. 1.* (Be sure that the bottom surface of the insulation will be at the same level as where the bridging cross each other. This can usually be done by placing the top of the *flange* midway in the depth of the joist.) Staple *closely* to both sides of each web bar and also between web bars. This will keep the insulation permanently mounted in place with a minimum of openings. Use  $\frac{3}{8}$ " staples when attaching to starter strips. ( $\frac{1}{4}$ " staples are long enough for attaching flange to flange.)

(B) Open insulation as in Fig. 2.

(C) **FIRST METHOD; FOR INSTANCE FOR 24" OC JOIST SPACING:** Use the extra wide Infra manufactured for this purpose, either Type 6PShw or Type 4PShw.

1) At the cross-bridging, *fully* expand about *half* the insulation, up to the intersection of the struts. *See Fig. 3.*

2) Using shears or the hands, cut or tear the remaining unopened *mass* completely through, top to bottom. *See Fig. 4.*

3) Expand *both* sections of the cut portion of the insulation across the remaining space on the other side of the intersection of the struts, and attach to the opened flange of an *unexpanded* strip of insulation held on the far side of the next joist. *See Fig. 5.* A narrow slit will show where the

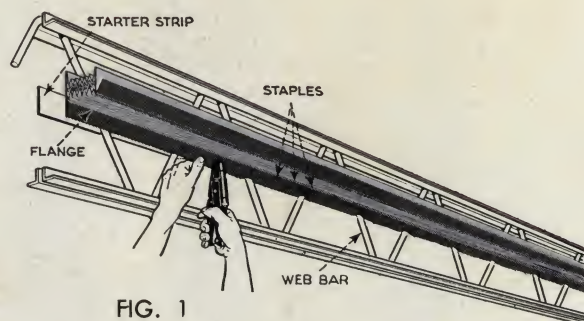


FIG. 1

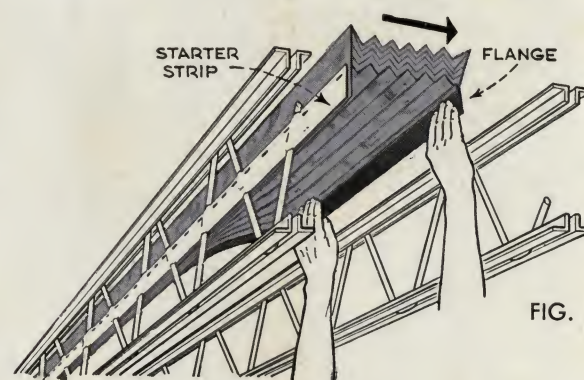


FIG. 2

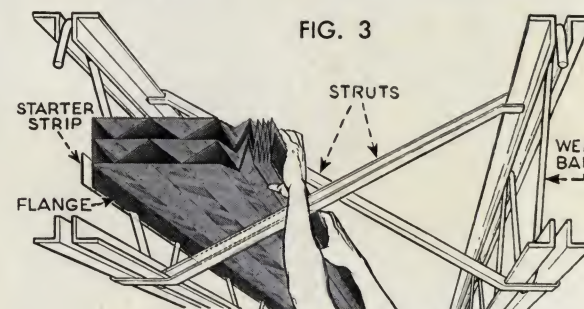


FIG. 3

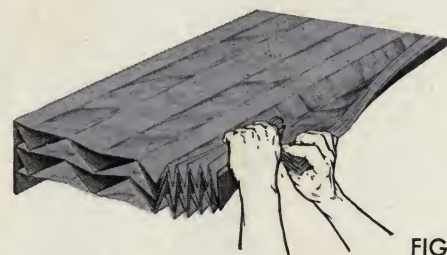


FIG. 4

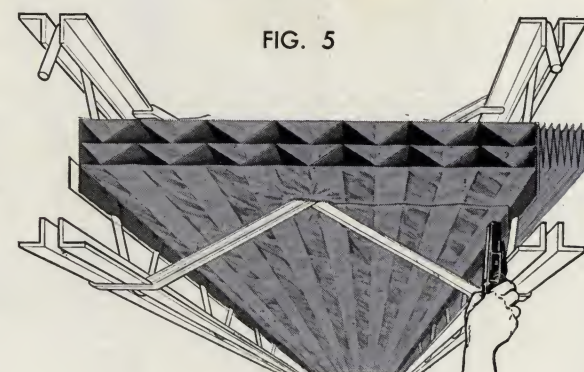


FIG. 5



former strip of insulation has been severed to expand around the bridging intersection. This slit can be neatly closed by bringing the two edges together to butt each other. Also tuck edges around the strut intersection.

4) If desired, in addition, a piece of aluminum about 12" x 17" can be stapled *over the slit* to extend 6" on each side of the slit (including the flange). The piece of aluminum should be extended 3" beyond the bridging intersection by notching the 3" extension lengthwise along its center. See Fig. 6. The Bostitch T5-8 Outward Clench Tacker can easily staple this piece of aluminum to the bottom aluminum sheet of the insulation. For neatness, staple close to the *edges* of the attached piece of aluminum.

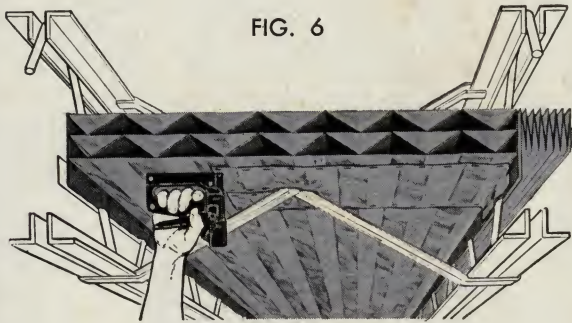


FIG. 6

5) Repeat the above steps with each new strip of insulation, on each bar joist, in each space; but using Infra Starter Strips again *only* on the outer side of the *outermost* joist to attach the last strip of insulation.

(D) SECOND METHOD; FOR INSTANCE FOR 30" OC JOIST SPACING, which can be spanned by 2 strips of insulation each the same width as the other; in this case each strip 16" oc. (For 36" or 37" spacing, use two 20" strips. For 48" space use two 24" extra wide strips. For 60" space, first attach to each other in *twos*, strips of 16" insulation; then use two of the resulting combination 30" strips.)

For EXTRA WIDE joist spaces, stretch strong, taut, aluminum wire about every 4 ft.; or instead, fasten at each end to the lower chords of adjoining joists, a small, steel, extruded 'T'; or small bridging type channel. This should be done *before* insulation is installed. See Fig. 7. (We furnish 7 strand, 18 gauge aluminum wire at 2¢ per ft.)

1) On first joist, staple insulation to starter strip as in paragraph "A" and Fig. 1, Page 10.

2) Staple two strips of unopened insulation in place on both sides of second joist. See Fig. 8.

3) Expand two *facing* insulation strips simultaneously in the same bay, toward each other, and staple the flanges together where they meet at the center. See Fig. 9.

4) At the cross-bridging *only*, make a *small* tear through the flanges to permit the struts to pass, and tuck flanges back into place. See Fig. 10.

5) Repeat the above steps with each new space or bay, but using Infra Starter Strips again *only* on the outer side of the outermost truss to attach the last strip of insulation.

(E) For small openings along the edges of the wall, use a narrow strip of Infra, or crumple aluminum and insert.

NOTE: We can furnish aluminum foil, Asbestos Starter Strips, Cardboard Strips, suitable stapling pliers and tackers, staples, aluminum wire, and suitable widths of Infra Insulation, including the extra wide Types 6PShw and 4PShw.

## HOW TO INSTALL ON STEEL BEAMS AND CHANNELS

When space above permits, staple first strip of closed Infra Type 6 or Type 4 along wall, perpendicular to and resting on channels. Then staple flange of 2nd closed Infra strip to unattached flange of 1st strip. Now open *previous* strip only. Repeat process throughout ceiling, stapling flange of last strip to the opposite wall.

**BETWEEN STEEL BEAMS:** DRILL HOLES through the steel beams every 3 feet and attach wood furring strips with bolts and nuts. Then attach the Insulation to the furring strips, using the stapling tacker.

**EXPOSED STEEL BEAMS:** Attach furring strips along sides and bottom (or top of beam), as circumstances require, and then staple Infra Insulation in place.

**WITH A WOODEN ROOF:** Attach lath or furring strips between steel beams to underside of roof on 16" or 24" centers. Staple Infra, **BOTTOM** side up to face of strips. It costs less, but insulation is somewhat less efficient when stapled direct to ceiling instead of to furring.

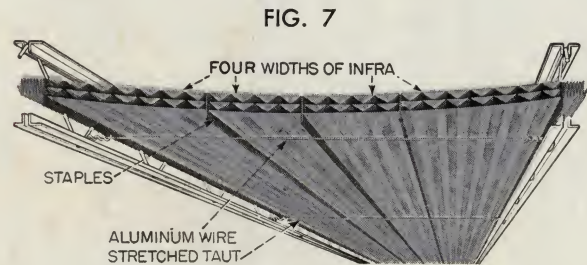


FIG. 7

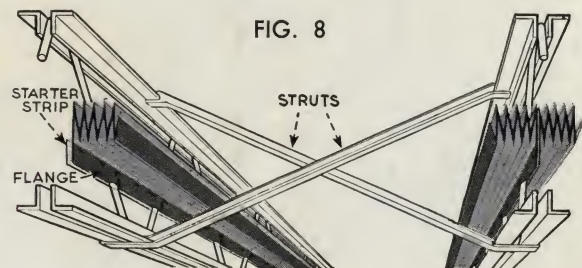


FIG. 8

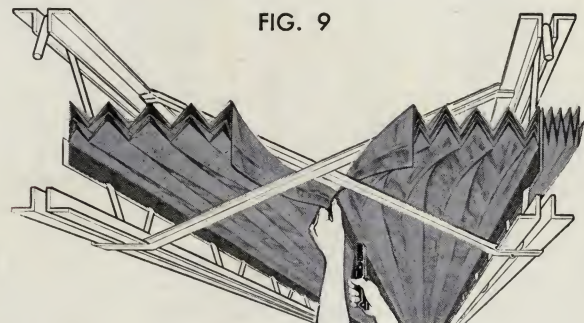


FIG. 9

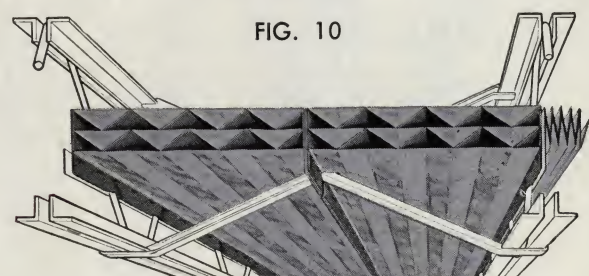


FIG. 10



# DUCTS

Excessive fuel costs can often be traced to metal hot air supply and return ducts which are located in unheated spaces. This is due partly to: 1—the large surface area of the ducts; 2—the high conduction of the duct walls and heat losses by convection from their surfaces; 3—the high temperature difference between the inside and outside of the duct (hot air is often supplied at about 130° F. and return air is at room temperature, while unheated spaces may approximate wintry outside conditions); 4—fuel needed to reheat the chilled air.

The remedy in these cases is to insulate the outer surfaces of these metal ducts which are vital arteries of the heat supply system, with insulation of low C factor, and low moisture absorption and retention properties.

Type 6PSh, 6PKh, or 4PSh Infra Accordion Aluminum Insulation can easily be attached to all 4 sides. Where there is insufficient room, Type 4 Jr. can be used. Type 6 comes in strips up to 375 ft. long, Type 4 in strips 750 ft. long.

IN EXTERIOR WALLS, heating ducts unfortunately are usually installed the full depth of the studs. *The depth of the ducts should be decreased* so as to enable the placing of insulation back of it. To conserve space, apply Type 4 Jr. before the ducts are installed.

## HOW TO INSTALL

(1) Lengths of insulation should be about 6" more than the length of the section of duct being worked upon. These will vary from 4 ft. to 16 ft. depending on arrangement of hangers or supports, and variations in duct sizes. (2) Ascertain the dimensions on 3 or 4 sides of the duct, excluding either the top or bottom side when the hangers or supports are too close to each other for efficient application. (3) Use as many strips of the necessary combination of widths as will equal or be wider than that dimension, joining them together according to instructions "FOR WIDE SPACES" on page 6. (4) Lay the unopened assembled strips along the edge of the duct where the hangers or supports are fastened. Open one edge starting flange, slit it to accommodate hangers, and tape it to duct with any tape. *See Fig. 1.* (5) Expand insulation fully while wrapping it around. (6) Where the installation is to first cover 3 sides, tape the last edge flange (*see*

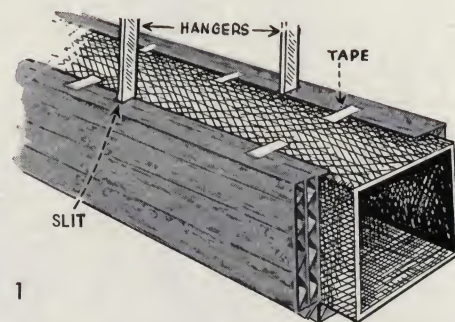


FIG. 1

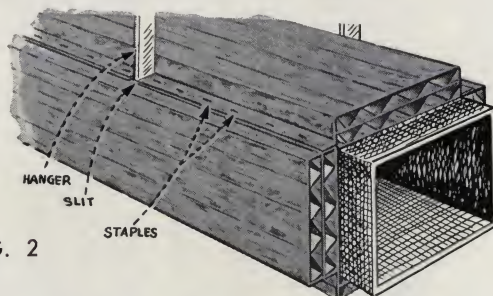


FIG. 2

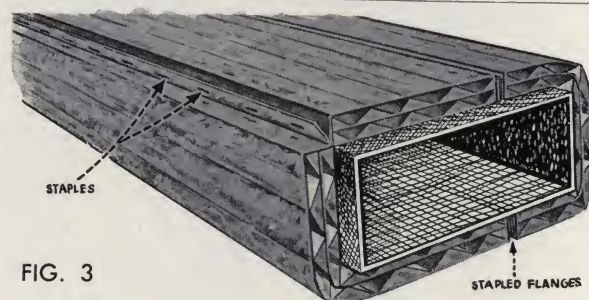


FIG. 3

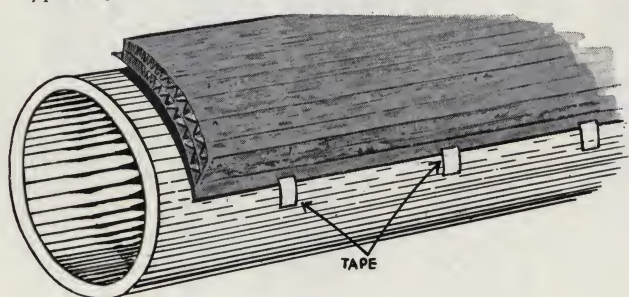
*Fig. 1*), and then place an expanded strip of insulation (or attached strips) of suitable width over the uncovered duct surface and staple its edge flanges to the taped-on insulation, using a Bostitch T5-8 Outward Clench Tacker, which we can furnish, and 1/2" staples. *See Fig. 2.* (7) Where the installation is to cover the 4 sides in one operation, bring the starting and ending flanges together and staple them to each other with either the T5-8 tacker or the P-6 plier. *See Fig. 3.*

# PIPES

**HOT AND COLD PIPES:** Hot pipes can often be protected against excessive heat loss; 'sweating' of cold pipes and freezing often prevented; by applying Infra to them.

Types 6PhP, 6APhP: (*for PIPES.*) Only 1 1/2" deep overall. Specially made 12" wide. 3 aluminum sheets, 6 reflective surfaces, 5 or 6 reflective spaces, and 2 accordion partitions; either of flame, mold and insect resistant fiber; or of ASBESTOS. BOTTOM surface of real tough aluminum, and TOP surface of *still thicker aluminum*. Trapezoid shape. Comes in 1 strip 500 feet long. Made to order.

Type 4 Jr. is 16" wide, 750 feet long. Where there are



space limitations, Type 4 Jr. or Type 4A Jr. which are only 1/2" deep, can be used.

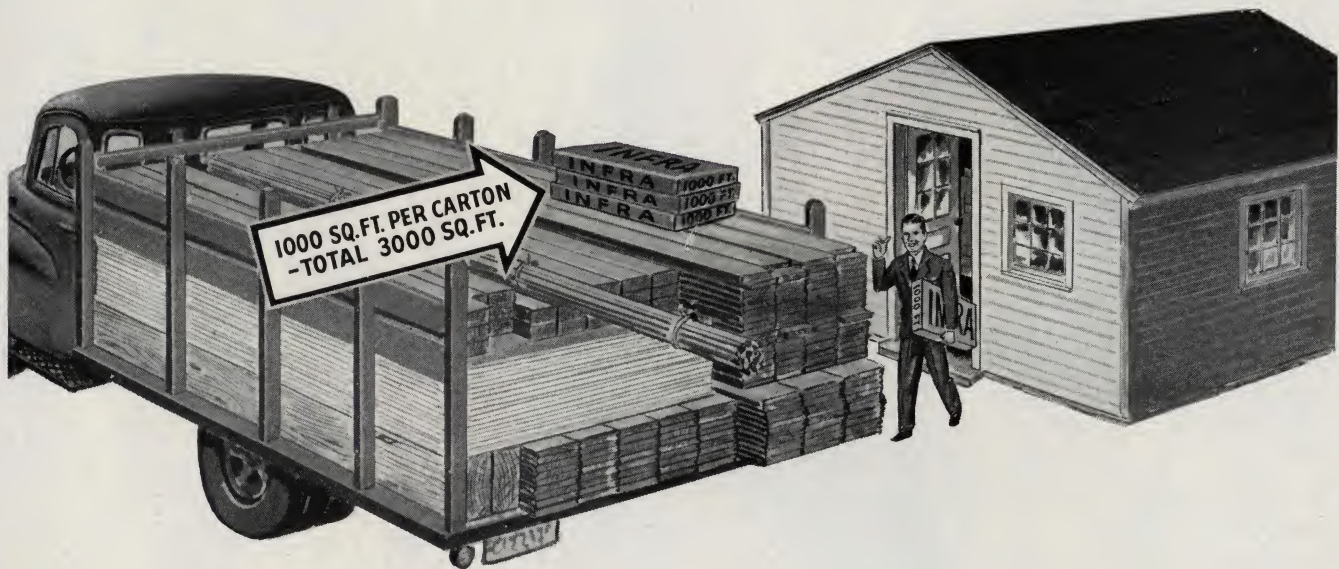
## HOW TO INSTALL

(1) Ascertain the circumference of the pipe. If it is wider than the width of a single Infra strip, staple 2 or more strips of Infra together according to instructions "FOR WIDE SPACES" on page 6. It does not matter if the insulation is wider than the circumference. (2) Tape one flange of the *unopened* insulation to the pipe. Only then expand the pleats while wrapping it around for its full width. *See Illustration.* Staple the other flange to the body of the insulation *wherever it comes to rest*, using the Bostitch T5-8 Outward Clench Tacker, which we can furnish, and 1/2" staples. It is not necessary to compress the insulation, as the spreading action of the outward clench staple will cause it to go through the flange and fasten to the top sheet of the insulation beneath if they are merely touching each other. (3) If the edge flanges happen to just meet, they can be fastened together with the Bostitch P-6 Stapling plier.



# Saves Valuable Storage Space

**CUTS--EVEN ELIMINATES--DELIVERY COSTS**



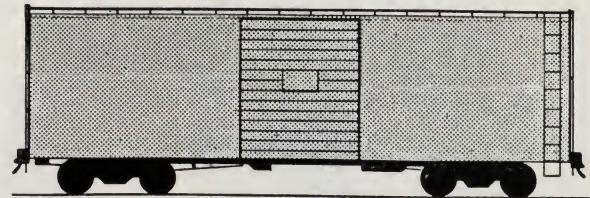
**"There's a Million Sq. Ft. of Insulation stored in that 10'x15' Shack—  
Ordinary Insulations Would Take 200 Such Shacks."**

One thousand square feet of ordinary insulation takes up a lot of shed space, may require half a truck for delivery, sometimes weighs a ton, filling a total of 25 cartons occupying 175 cubic feet. But the SAME AMOUNT of Type 4 Infra Insulation will occupy but ONE carton of only 1¼ cu. ft.; weigh only 45 lbs.; minimize storage and handling problems. A man can tuck a carton of 1,000 sq. ft. under his arm and take it to the job on a bus. Furthermore, it costs less than ordinary insulations.

. . . . .

## 18,000 SQ. FT. IN AN AUTO

Enough Infra Insulation can be tossed into the trunk compartment of a passenger car to insulate an entire attic or crawl space. A contractor can carry 18,000 sq. ft. in his passenger automobile. The same amount of ordinary insulation would fill a freight car or 3 trailer trucks.



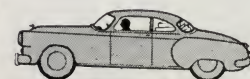
## THIS FREIGHT CAR

Holds 18,000 sq. ft. Ordinary Insulation

But Can Hold

1½ MILLION sq. ft. Infra Insulation

. . . . .



## THIS PASSENGER CAR

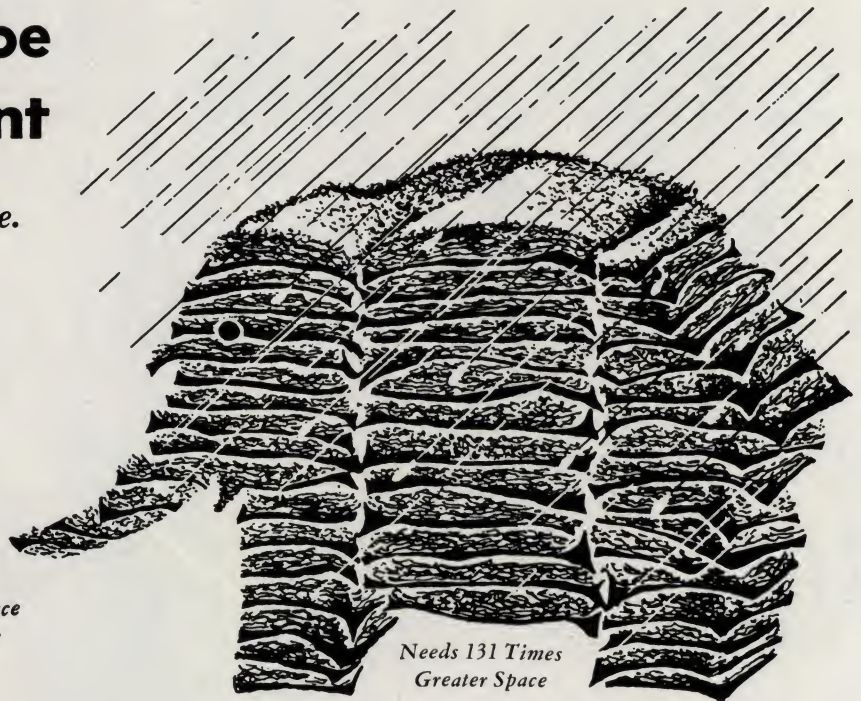
Holds 18,000 sq. ft. Infra Insulation



# Insulation can be a White Elephant

*It can clutter up a building site.*

*And if it rains before the building's up...!*



Storage space is so scanty at congested building sites, even if materials are piled up outdoors — that bulky, ordinary insulation must too often be left exposed to the weather, exposed even to rain, where it can become sopping wet before and during installation.

Pilferage and congestion cause delays and become annoying problems. But with Infra Insulation a few small cartons tucked in a corner are hardly noticeable, occupying a negligible amount of space. One man can unload 20,000 sq. ft. of Infra in *minutes*. But it would take a *crew* a few *HOURS* to unload that much ordinary insulation (about 500 bundles).

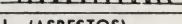
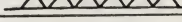
Easy to handle and install, contractors work rapidly with Infra. The average experienced applicator can install about 2,000 sq. ft. of it per day. Some have been known to install from 3,000 sq. ft. to 4,000 sq. ft. in a single day.



Man carries under one arm, in one trip, in one carton, 1,000 sq. ft. of Infra Insulation weighing 45 lbs., occupying 1 1/4 cu. ft. One thousand sq. ft. of ordinary insulation occupies 175 cu. ft., weighs 2,000 lbs., fills 25 large bundles, requires 25 trips to unload, sometimes with 2 men.



# DESCRIPTION OF VARIOUS TYPES OF INFRA INSULATIONS

| TYPES                                                                                                             | Beam Centers         | Sq. Ft. per Carton  | 1000 Sq. Ft.  |                 | DESCRIPTION OF TYPES                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------------------|----------------------|---------------------|---------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                   |                      |                     | Weight Lbs. † | Storage Cu. Ft. |                                                                                                                                                                                                                                                                                                                                |
| 4PS** (standard) 1 1/4" deep<br> | 16", 24"<br>16"      | 1000<br>250         | 60            | 2 1/2           | Popular for ceilings and under floors. Best and driest insulation for wall spaces. Newest, full depth, edge-to-edge insulation. 4 reflective surfaces, 4 reflective spaces, 2 tough aluminum sheets, flame and insect resistant fiber separator.                                                                               |
| 4PShm** (heavy metal)                                                                                             | 16", 24"             | 1000                | 82            | 2 1/2           | Same as 4PS except aluminum is extra thick. Used if either surface is exposed.                                                                                                                                                                                                                                                 |
| 4PSHLL* (heavy, laminated)                                                                                        |                      | 500                 | 96            | 3               | Same as 4PS but bottom and top sheets are tough, 3-ply laminate.                                                                                                                                                                                                                                                               |
| 4PSHwLL* (wide) 4PSHmw                                                                                            | 24" plus             |                     |               |                 | For steel beams, trusses, etc. Same as 4PSHLL, 4PShm, 24", except 1 3/4" wider.                                                                                                                                                                                                                                                |
| 4PS-PLUS<br>                     | 16"                  | 500                 | 90            | 4 3/4           | Same as 6PK minus top metal. Helps in F.H.A. ventilated attics without floors.                                                                                                                                                                                                                                                 |
| 4PC** (1 1/4" deep)<br>          | 16"<br>12", 20", 24" | 1000<br>250<br>1000 | 38            | 1 3/4           | Same as 4PS except trapezoid in shape, and aluminum is not quite as thick.                                                                                                                                                                                                                                                     |
| 4PChm** (heavy metal)                                                                                             | 16", 20", 24"        | 1000                | 68            | 1 1/2           | Same as 4PC except aluminum is extra thick. Used if either surface is exposed.                                                                                                                                                                                                                                                 |
| 4PCHLL* (heavy, laminated)                                                                                        |                      | 500                 | 77            | 2               | Same as 4PC but bottom and top sheets are tough, 3-ply laminate. To order.                                                                                                                                                                                                                                                     |
| 4AP (ASBESTOS)                                                                                                    | 16"                  | 500                 | 89            | 2 1/2           | Same as 4PC except separator is ASBESTOS.                                                                                                                                                                                                                                                                                      |
| 4PC-PLUS (2 1/2" deep)<br>       | 16", 24"             | 500                 | 66            | 3               | Same as 6PC minus top metal. Helps in F.H.A. ventilated attics without floors.                                                                                                                                                                                                                                                 |
| 4 Jr. (1/2" deep)<br>            | 16"                  | 500                 | 44            | 3               | Used in block or brick walls, and where space is limited. 4 reflective surfaces and spaces. 2 aluminum sheets; flame, mold, insect resistant fiber separator.                                                                                                                                                                  |
| 4A Jr. (ASBESTOS)                                                                                                 |                      | 250                 | 78            | 8               | Same as 4 Jr. except fiber separator is ASBESTOS.                                                                                                                                                                                                                                                                              |
| 6PS** (standard) 3" deep<br>     | 16", 24"             | 250                 | 137           | 10              | Best for ceilings, roof spaces, crawl spaces, cold storage, air conditioning. Newest, full-depth, edge-to-edge insulation. 6 reflective surfaces, 6 reflective spaces, 3 tough aluminum sheets, 2 flame, mold and insect resistant fiber separators. Center aluminum is 1 1/4" from top aluminum, 1 1/4" from bottom aluminum. |
| 6PShm** (heavy metal)                                                                                             | 16", 24"             | 250                 | 159           | 11              | Same as 6PS except aluminum is extra thick. Used if either surface is exposed.                                                                                                                                                                                                                                                 |
| 6PSHLL* (heavy, laminated)                                                                                        |                      |                     | 169           | 13              | Same as 6PS but bottom and top sheets are tough 3-ply laminate.                                                                                                                                                                                                                                                                |
| 6PSHwLL* (wide) 6PSHmw                                                                                            | 24" plus             |                     |               |                 | For steel beams, trusses, etc. Same as 6PSHLL, 6PShm, 24", except 1 3/4" wider.                                                                                                                                                                                                                                                |
| 6PSHB (black bottom)                                                                                              | 16", 24"             |                     | 159           | 11              | For temperatures above 150°F. Same as 6PShm but bottom surface is black. To order.                                                                                                                                                                                                                                             |
| 6PK** (2 1/2" deep)<br>        | 16", 24"<br>16"      | 500<br>250          | 104           | 4 3/4           | Same as 6PS, except that all 3 aluminum sheets are separated 1 1/4" from each other, and TOP sheet is .0007" thick.                                                                                                                                                                                                            |
| 6PKhm** (heavy metal)                                                                                             | 16", 24"             | 500                 | 128           | 6               | Same as 6PK except aluminum is extra thick. Used if either surface is exposed.                                                                                                                                                                                                                                                 |
| 6PKHLL* (heavy, laminated)                                                                                        |                      | 250                 | 139           | 7               | Same as 6PK except bottom and top sheets are tough, 3-ply laminate.                                                                                                                                                                                                                                                            |
| 6PC** (2 1/2" deep)<br>        | 12", 16"<br>20", 24" | 500                 | 78            | 4               | Same as 6PK and 6PKhm, except trapezoid in shape, and aluminum is not quite as thick.                                                                                                                                                                                                                                          |
| 6PChm** (heavy metal)                                                                                             | 16", 24"             | 500                 | 103           | 4 1/2           | Same as 6PC except aluminum is extra thick. Used if either surface is exposed.                                                                                                                                                                                                                                                 |
| 6PCHLL* (heavy, laminated)                                                                                        |                      | 250                 | 113           | 5 1/2           | Same as 6PC but bottom and top sheets are tough, 3-ply laminate. To order.                                                                                                                                                                                                                                                     |
| 6AP (ASBESTOS)                                                                                                    | 16", 24"             | 500                 | 164           | 8               | Same as 6PC except separators are ASBESTOS.                                                                                                                                                                                                                                                                                    |
| 6PCMF (fiber bottom)                                                                                              |                      |                     | 79            | 4               | Used where exposed aluminum is not wanted. Same as 6PC but bottom accor-dion is metal, and bottom surface is fiber.                                                                                                                                                                                                            |
| 6PhP (pipes. 12" wide)                                                                                            | 12"                  | 500                 | 130           | 6               | 1 1/2" deep for pipes. 3 aluminum sheets, 2 flame, mold, insect resistant fibers.                                                                                                                                                                                                                                              |
| 6APhP (ASBESTOS)                                                                                                  |                      |                     |               |                 | Same as 6PhP except separators are ASBESTOS.                                                                                                                                                                                                                                                                                   |
| 2PS (1 1/4" deep)<br>          | 12", 16"<br>24"      | 1000                | 34            | 1 1/4           | 2 reflective surfaces, 2 reflective spaces and 1 non-reflective space. 1 tough aluminum sheet and flame, mold and insect resistant accordion fiber.                                                                                                                                                                            |
| 2Pc (crawl space)                                                                                                 | 16", 24"             |                     |               |                 | Used in crawl spaces. Same as 2PS but accordion fiber is asphalt impregnated and waterproof. For best thermal results, fiber faces down and hangs loose.                                                                                                                                                                       |
| Accordion Retardive<br>        | 16", 24"             | 1000                | 28            | 1               | 2 reflective surfaces. Tough, untreated fiber, laminated between 2 aluminum sheets. For crawl spaces, stripped side walls, convactor radiators, etc.                                                                                                                                                                           |
| Flat Retardive (all Metal)                                                                                        | 36"                  |                     | 21            | 1/2             | For water and vapor-proofing, insulating, wind-breaking. .0015" aluminum.                                                                                                                                                                                                                                                      |

\*"L" stands for 3-ply laminate, made of tough non-treated kraft between 2 sheets of aluminum. Single "L", 4PSHL, 4PSHwL, 4PCHL; 6PSHL, 6PSHwL, 6PKHL, 6PCHL. Single "L", bottom sheet 3-ply laminate, top extra thick all-metal.

\*\* Available to order with metal on flanges exposed. Type names, 4PSe, 4PShme, 4PCe, 4PChme, 6PSe, 6PShme, 6PKe, 6PKhme, 6PCE, 6PChme.

6PSt, 6PKt, 6Pct, 4PSt; and 4Pct—(thinner) 16" centers. Same as 6PS, 6PK, 6PC, 4PS and 4PC respectively except aluminum is not quite as thick and separating fibers are not flame, mold and insect resistant. Made only to order to meet competition of insulations which use extremely thin aluminum and non-flame-resistant kraft.

†Weight of insulation itself. Cartons weigh about 4 3/4 lbs.



## SUGGESTED SPECIFICATIONS

### **A. SHORT FORM**

If you wish to specify *Infra Insulation* by name, specify:

**A.** "INFRA MULTIPLE ALUMINUM INSULATION, installed in accordance with directions of manufacturer, *Infra Insulation, Inc.*, 525 Broadway, New York City."

"CEILINGS: Type 6PS *Infra* (or 6PShLL, 6PShm, 6PK, 6PKhLL, 6PKhm, 6AP, 4PS, 4PShLL, 4PShm, 4AP) .

"EXTERIOR WALLS: Type 4PS *Infra* (or 4PShLL, 4PShm or 4AP) .

"FLOORS OR CRAWL SPACES: Type 6PShLL (or 6PShm, 6PS, 4PShLL, 4PShm, 4PS or 4AP, 2PS or Retardive) ."

### **B. FIRST ALTERNATIVE SPECIFICATION**

If you wish to consider *generally any kind of insulation* so long as it meets the following requirements, specify:

**B.** a. "Both outer surfaces of the insulation shall have a water vapor permeability of almost zero.

b. "The vapor barrier material shall be long and continuous; with no "breaks" from top to bottom as installed in walls, and few (if any) "breaks" as installed in ceilings or floors.

c. "IF FIBROUS INSULATION is installed, it shall be not less than 4 inches thick for ceilings and floors; and not less than 2 inches thick for walls."

d. IF REFLECTIVE INSULATION IS INSTALLED:

"Thermal insulation shall have expansible, multiple sheets of aluminum, with multiple reflective surfaces and spaces, which insulate from joist to joist with full, uniform depth, and from edge-to-edge of the insulation, the entire surface area of the space to be insulated. Aluminum sheets shall be separated not less than 1" apart throughout to the very edges, by spacing media so that at no place will aluminum "face" aluminum, and so that aluminum cannot touch aluminum even if insulation should be so installed that any aluminum sheet should sag.

"Each aluminum sheet must reach from joist to joist.

"The 2 outer sheets shall have a bursting strength not less than 17 lbs. and 12 lbs. per sq. inch (for "S" or standard types; but for "h" or heavy types "not less than 50 lbs. and 20 lbs., or else 3-ply laminate.")

"CEILINGS: 3 aluminum and 2 fiber sheets, 6 reflective surfaces, 6 reflective spaces. (Or, 2 aluminum sheets, 1 fiber, 4 reflective surfaces, 4 reflective spaces) .

"WALLS: 2 aluminum sheets, 1 fiber, 4 reflective surfaces, 4 reflective spaces.

"FLOORS or CRAWL SPACES: 3 aluminum and 2 fiber sheets, 6 reflective surfaces, 6 reflective spaces. (Or, 2 aluminum sheets, 1 fiber, 4 reflective surfaces, 4 reflective spaces) .

### **C. SECOND ALTERNATIVE SPECIFICATION**

If you wish to specify *aluminum insulation*, but in *general* terms:

**C.** "Use sub-section "d" of section B of FIRST ALTERNATIVE SPECIFICATION."

FOR DESCRIPTIONS OF THE VARIOUS TYPES OF INFRA INSULATIONS, SEE REVERSE SIDE OF THIS SHEET.



# HEAT FLOW BY RADIATION IN BUILDINGS

## SIMPLIFIED PHYSICS

by Alexander Schwartz, president Infra Insulation Inc.  
 Author of "Simplified Physics of Vapor and Thermal Insulation."

### PREFACE

*If a building is uncomfortably cold in winter; or uncomfortably warm in summer; or if the cost of fuel is excessive; then the architect, engineer, builder, heating contractor and insulation applicator will all be exposed to criticism by the occupants and its owners.*

*This applies to dwellings, schools, hospitals, factories, churches, stores, offices, farm buildings, cold storage, etc.*

*If timber should rot, paint should peel, masonry crumble, ceilings and walls get discolored from water and dust streaks, there will also be criticism.*

*The author has tried to tell in simple language the important part that Radiation plays in these problems and the manner in which it does so, as well as the characteristics of Radiation. As far as possible the discussions have been limited to general problems and conditions that may be found in ordinary building construction.*

\*We will forward on request a free copy of the ORIGINAL complete work of the authority quoted, where an asterisk (\*) appears in this booklet.

### COLD

"Does insulation keep out the cold?" is a question frequently asked.

The answer is: — only as do ordinary materials such as glass, brick, building paper, etc., to the limited extent that it prevents wind infiltration.

Cold is the absence of heat. It is heat that flows — — — in the direction of cold; except sometimes otherwise in convection, or in forced convection such as is produced by a fan.

Suppose windows were open, or there were holes or crevices in a heated building. Further suppose that the outside air, though very cold, were *absolutely still*. Cold would NOT come in. But HEAT would LEAVE through such openings, partly by convection, a little by conduction, and considerably by radiation, till thermal equilibrium between the building and the surroundings were reached.

*Even without any openings or holes, even assuming the building were sealed perfectly air-tight, the heat would nevertheless leave that structure in winter, but with less rapidity; also by radiation, conduction and convection.*

Suppose two small, warm boxes, identical except that one had some openings in it, were placed into a very cold refrigerator with still air. Heat would leave both boxes until temperature equilibrium with the refrigerator was reached; but more rapidly in the case of the box with the openings.

So the problem is the study of the FLOW of HEAT, or "HEAT TRANSFER."

### HEAT TRANSFER

All substances, including all building materials (and insulations), *transfer* heat or *resist* heat-flow by the *same methods*. The same laws of nature are obeyed by all physical objects, including aluminum, paper, cotton, wood, wood-fibers, rock, slag, glass, mineral wool, air spaces, plaster, brick, steel, humans, animals, plants, the sun, the earth, etc.

Heat flows only by Conduction, Convection and Radiation.

The differences are in the INTENSITY of Conduction, the RATE of radiant *Absorptivity* and *Emissivity*, the AMOUNT of *Convection*.

These quantitative differences are due to differences in: density; weight; shape; permeability; molecular structure of surfaces; and other ordinary, physical properties.

### DEFINITION OF TERMS

**Btu** or British Thermal Unit. The amount of heat needed to raise the temperature of 1 lb. water 1 degree Fahrenheit.  $1^{\circ}\text{F}$ .

**Conductivity or  $k$  factor**, is the rate of heat flow in Btu's, per hour, through 1 sq. ft. of a *homogeneous material* that will result from a  $1^{\circ}\text{F}$ . temperature difference between its 2 surfaces, PER INCH OF THICKNESS. (Reflective insulation not being homogeneous, the  $k$  factor is *not applicable*; but the C, R, and U factors *are* applicable. As a matter of fact, *most* insulations are not homogeneous, since they contain a mixture of air spaces as well as fibers, and often also paper.)  $k$  is often confused with Conductance or C factor.

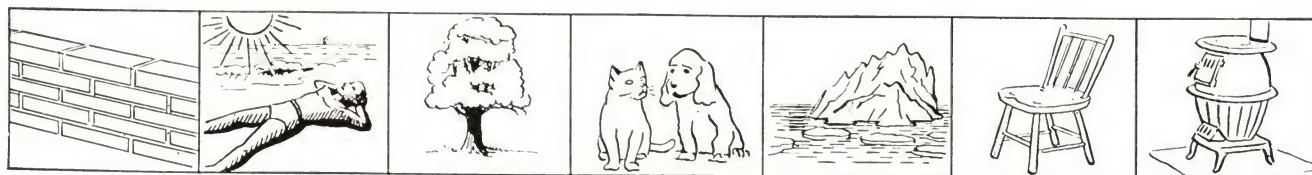
**Conductance or C factor** is the rate of heat flow in Btu's, per hour, through 1 sq. ft. of any material whether homogeneous or non-homogeneous, of whatever thickness or shape, resulting from  $1^{\circ}\text{F}$ . temp. difference between its 2 surfaces.

**U factor** is rate of heat flow, or "overall coefficient of heat transmission" in Btu's in one hour through one sq. ft. area of the entire depth of ceiling, roof, wall, or floor, including insulation if any, which will result from a  $1^{\circ}\text{F}$ . temperature difference between the air inside and the air outside.

**R factor or Resistance** to heat flow: — is the reciprocal of C,  $k$ , or U; in other words, mathematically  $\frac{1}{C}$ ,  $\frac{1}{k}$ ,  $\frac{1}{U}$ .

(The *smaller* the C,  $k$ , or U factor fraction, and the larger the R factor, the **BETTER** is an insulation.)

**Conduction** is direct heat flow *through* matter, resulting from actual *physical contact* of one part of the same object with its adjoining part, or from contact of one object with another. The object may be a gas such as air; or a dense solid such as iron, lead or uranium. The transmission of heat is by molecular motion, in which the molecules transmit their energy to adjoining molecules whose motion is thereby increased. This raises their temperature without significant



THEY ALL OBEY THE SAME LAWS OF HEAT FLOW



displacement of the particles. The direction of heat flow by conduction is from warm to cold *only*, in *any* direction; NEVER from cold to warm.

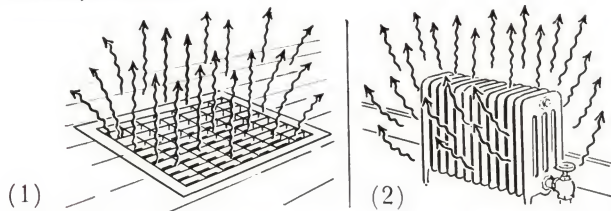


### CONDUCTION

- (1) *Through poker.*
- (2) *Between top of closed stove and bottom of kettle.*
- (3) *Film of air in immediate contact with surfaces of stove, kettle and poker.*

**Convection** heat flow is the transfer or transportation of heat which is within a gas or liquid, caused by the flow of the heated gas or liquid itself. In building spaces, convection heat flow is largely upward, somewhat sideways; not downwards.

Convection may be mechanical, such as by a fan; called "forced convection." It may be "free convection," by *natural* means, as usually occurs in building spaces. For instance when a warmer stove, convactor, person, floor, wall, furniture, etc. first loses heat by Conduction to cooler air in contact with it, the added heat activates the molecules of the air. The warmed air expands and becomes less dense, and rises. Cooler, heavier air rushes in from the sides to replace it. The popular expression is, "Hot air rises." Smoke rising from a chimney or cigarette, is also an example of convection. The motion is turbulently upward, with a component of sideways motion.



**CONVECTION** (1) Warm air rising from register. (2) Warm air rising from all surfaces of radiator (after air in contact with radiator has been heated by conduction).

## RADIATION

Thermal **RADIATION** is the transmission through **SPACE** of *energy* by means of electromagnetic rays of long wave length.

The sun, for example, radiates energy to the earth through 93 million miles of space, by means of rays of many different wave lengths. The rays which predominate are those of long wave length, called 'infra-red' rays, or heat-rays.

But the source does not have to be the sun, and the space does not have to be so large. Every exposed surface of every object in the universe with a temperature above *absolute zero* gives off infra-red rays in varying amounts. These rays travel through whatever space there may be between that surface and the surface of another object facing that space; be it an inch or a million miles away.

The *surfaces* of an iceberg, a wall, a stove, a radiator, a human being, clothing, animals, a chair, table, desk, floor, ceiling or roof, a piece of wood, paper, a dust particle, rock, ordinary insulation, etc., *all radiate*. All have some heat within them, all are above *absolute zero* in temperature. (Many problems of heat transfer are calculated and determined with the use of "absolute zero," instead of zero on the Fahrenheit or the Centigrade Scales.)

## AIR SPACES IN BUILDINGS

The greatest flow of heat possible between solids is by *direct conduction*.

*Air-spaces* in buildings, as in outer walls, roof and floor spaces, reduce heat flow by conduction, because air is a gas and has slight density. This reduces heat loss in winter, and heat intake in summer.

Because air has low density, "The percentage of heat transferred by conduction through air is comparatively small." (*Building Insulation*, page 104, P. D. Close†.)

A ceiling or roof *space* has a Resistance factor, *R*, against up heat flow of .76; against down heat flow as much as 1.06. A building wall *space* has a Resistance factor to the flow of heat sideways of .91. (The corresponding *C* factor values are *C* 1.32, *C* .94 and *C* 1.10 respectively.) If these spaces were eliminated, there would be that much *less resistance* to heat flow, and so greater heat flow, greater conductance.

However, an air space is a good medium for heat flow by radiation and convection, which create new problems.

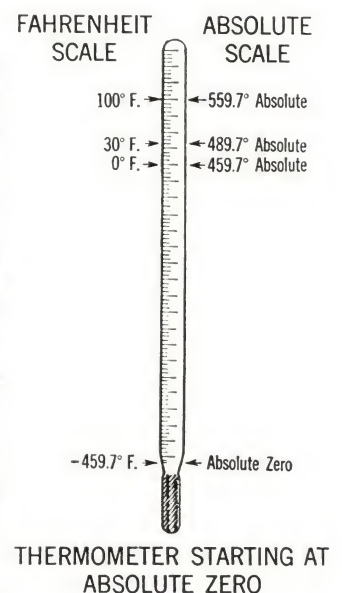
The BUREAU OF STANDARDS in its Circular No. 376 entitled "Thermal Insulation of Buildings" says on page 3.

"Although air is a very poor conductor of heat, the insulating value of an ordinary air space is rather small, on account of the large transfer of heat by convection and radiation. Radiation is largely responsible for the ineffectiveness of air spaces bounded by ordinary building materials, such as are found in frame or other hollow walls. The low insulating value is often erroneously attributed to convection; but, as a matter of fact, from 50 to 80 per cent of the heat transfer across air spaces of ordinary sizes takes place by radiation. If the air spaces were bounded by bright metallic surfaces, the transfer of heat by radiation would be greatly diminished, since clean metallic surfaces are much poorer radiators than non-metallic surfaces, such as brick, stone, glass, wood, paper, etc."

**ABSOLUTE ZERO** is the very lowest theoretical temperature that can be attained. It is minus 459.7° F., or 459.7 degrees below zero on the Fahrenheit scale. Therefore 459.7 is the amount to be *added* to the Fahrenheit temperature of an object in order to ascertain its *Absolute temperature*.

For example, a temperature reading of 30° on the Fahrenheit scale, would on the Absolute scale be 459.7° *plus* 30°, or 489.7°. A temperature of 100° F. would be 559.7° Absolute. *See illustration.*

Most rays are invisible! The few that are visible are known as *Light*. On either side of the light rays in the spectrum are the invisible ultra-violet and infra-red rays, which are now almost as familiar to the public as they are to scientists. The small range of visible rays: violet, blue, green, yellow, orange



†Mr. Close was Technical Secretary of Insulation Board Institute and previously Technical Secretary of the American Society of Heating and Air-Conditioning Engineers. Publishers: American Technical Society, Chicago, U.S.A. Price \$4.50.



and visible red, all known as *Light*, constitutes only 1 octave out of the 66 octaves of rays.

The different rays have different wave lengths, progressively longer on one side of the spectrum, and progressively shorter on the other side. The rays that lie between *one* ray of a certain length, and another ray which is *twice* as long or *half* as long, are called an octave. (A rough analogy is the more familiar octave in the field of music.)

The light rays have comparatively short wave lengths, and engender comparatively little heat. By far the greatest amount of heat is engendered by the series of rays called infra-red or heat rays, with their long wave-lengths, extending over many octaves.

Heat rays are not only invisible, but they have *no temperature*; only *energy*.

Heat rays are transmitted through space at great speed: about 186,000 miles per *second*, the same speed as that of *Light*. They travel till they strike another surface. Then they are either absorbed or reflected by that surface.

For example, the surfaces of the exposed portions of our bodies are constantly emitting heat rays to the surfaces around us, which in turn are constantly radiating to us.

### DIRECTION

The direction of flow in radiation is said to be from *warm* to cold; because while there is a flow of rays from and to each surface facing the same space, only the *net* transfer of heat rays across a space between two surfaces is of practical importance. Infra-red heat rays travel away from *every point* of the surface in a straight line in *any direction*, with the greatest intensity perpendicular to the surface, decreasing to zero intensity *along* the surface. *Illustrated on page 21.*

"When a surface radiates heat, and every surface does unless its temperature is absolute zero, every point of the surface radiates heat in all directions." 1950 A.S.H.A.E. Guide, page 526.

## THREE PROCESSES IN RADIATION

Radiation involves three processes. One is the flow of rays emanating from a surface of an object, because of heat within it. This is called Emission and its measure or rate is called Emissivity. The other two processes are called Absorption and Reflection; their rates, Absorptivity and Reflectivity.

### BASEBALL AND SHOTGUN ANALOGIES

When a pitcher throws a ball, it is set in motion because of energy *within* the player. We might liken the movement of that ball to Emission or Emissivity from a surface.

When the ball is bunted and its direction reversed, we can liken that to Reflectivity of the ray by the 2nd surface.

The catching of a ball might be likened to Absorptivity by the receiving surface.

Picture a shotgun or machine-gun in action. The bullets emanating from the barrel because of energy from the powder charge, might be likened to the flow of rays which emanate FROM a surface, or Emissivity.

Now picture the same bullets striking a wall. Those which *penetrate* are *absorbed*. It might be likened to Absorptivity.

Those which do not penetrate might be said to be rejected, deflected. This might be likened to Reflectivity.

The percentage of bullets which penetrate and are absorbed, compared to those which do not and are reflected, depends to a large measure on the type of *surface* on the wall. A surface of cloth, wood, paper, etc. would result in a larger percentage of absorption (of bullets) and a smaller percentage of their reflection, than a surface of hard steel.

A third analogy: The flow of water from a hose might be

likened to Emissivity; the absorption of the water by the surface sprayed, to Absorptivity; and the water which bounces back, Reflectivity.

## EMISSIVITY

The RATE of heat-ray flow from a surface, or its emissivity, is related to the ability of that surface to absorb heat rays. It is measured by comparison with the rate of a surface which under the same conditions would absorb all the radiation which struck it and reflect none.

The *rate* of radiation from a surface is not affected by the distance apart of the two surfaces. They may be millions of miles apart, like the sun and the earth; or a few inches or feet apart, like the surfaces in building spaces.

The emissivity of a material is a physical property belonging to it, just as weight, color, shape, etc. are physical properties. It can be determined with good accuracy by standard measurement techniques. Emissivity describes the *rate* at which radiant heat energy is emitted by a given surface.

All materials have emissivities, theoretically ranging from *zero* to *one* (100%) in value. *No* energy at all would be radiated from a surface of zero emissivity, while at the other extreme is a surface with emissivity of *one* or (100%).

The term "*emissivity*," which means the *rate* of heat ray flow from a surface, is *not* the same as the *amount* of heat ray flow. The amount will vary, with length of time of exposure, temperature, heat capacity of object, etc.

### SURFACE DETERMINES EMISSIVITY

The emissivity of ordinary materials such as wood, paper, glass, rock, asphalt, slag, ordinary insulations, etc. is about 90% of the maximum rate. Commercially pure aluminum such as aluminum foil has an emissivity of only 3% to 5%; very close to the zero end of the emissivity scale.

If two objects alike in *every* respect including substance, size, weight, temperature, kind and area of surface; were both equidistant from and "faced" the same surface of a third object for the same length of time, not only the rate but the amount of heat-rays flowing from them to that other surface in a given time would be equal.

*Regardless* of the substance of which the two identical objects were composed, if the *surface* of one were then covered with a material of 90% emissivity, and the surface of the other with a material of 3% emissivity, there would result a drastic difference in the rate of radiation or heat-ray flow from these two otherwise identical objects.

For instance, take four identical, unpainted iron radiators of about 24% surface emissivity. Paint one with aluminum or bronze paint; another with ordinary paint. Cover the third with asbestos and the fourth with aluminum foil. Although all had the same temperature, the one covered with aluminum foil of 3% emissivity would radiate the least because it would have the lowest emissivity. The radiators covered with ordinary paint or asbestos would radiate most, because they have the highest emissivity, much higher than aluminum paint, even higher than the original iron. (See Table, page 22.) Painting *over* the aluminum paint or foil with ordinary paint, changes the *surface* to 90% emissivity.





## ABSORPTIVITY AND REFLECTIVITY

When energy rays of any wave length strike the **SURFACE** of an object, to the extent that the rays are **ABSORBED**, heat is engendered in the object. This heat then spreads throughout the mass by **CONDUCTION**. The infra-red rays with their long wave lengths, engender *enormously* more heat than do light rays with their short wave lengths.

Heat-rays which are not absorbed by a surface which they strike, are **TURNED BACK**, reflected back.

The terms "absorptivity" and "reflectivity" signify *rates* at which heat-rays are absorbed or reflected by surfaces. There is a relationship between these rates.

Ordinary materials with high emissivity rates of 90% have a correspondingly high absorptivity rate of 90%. They also have low powers of reflection, 10%, for the long-wave-length heat-rays. But an aluminum foil surface with a very low emissivity rate of 3% has a correspondingly low absorptivity rate of 3%, and a high reflectivity of 97%.

In the case of a few materials, for instance gases (including air), a large portion of the heat rays can *pass right through* without being either absorbed or reflected. Pure rock salt, which is essentially sodium chloride, is also highly diathermic, and will permit a good deal of radiation to pass through without absorbing or reflecting it. Only a very small frequency range of the *heat* rays will be transmitted through quartz, glass and water; although these substances can transmit the rays of *light*, ARE *transparent* to light.

But the surfaces of most building materials including ordinary insulations, are high absorbers, high emitters, and poor reflectors of radiation, with an absorptivity and emissivity of about 90% and over, and a reflectivity of 10% or less.

Dr. J. L. Finck stated in the *Jan. 1935* issue of *The Architectural Record*,

"As a matter of fact, practically all materials used in building construction — brick, stone, wood, paper, and so on — regardless of their color to visible light, are over 90 per cent black for infra-red radiation. Therefore, air spaces within building walls are bounded by materials which are good absorbers of the radiation which impinges upon them."

### METALS ARE THE BEST INSULATORS

The surfaces of metals are generally very good reflectors, and poor absorbers and poor emitters of radiation. Those of gold, silver and aluminum, have a reflectivity of over 95%, with an absorptivity and emissivity of 5% or less. Even ordinary iron has 24% emissivity and 76% reflectivity.

In their book "*INSULATION*," Dalzell & McKinney† state on page 29,

"Thermal insulation with a metal is made possible by taking advantage of the low thermal emissivity of aluminum foil and

the low thermal conductivity of air. It is possible with this type of insulation practically to eliminate heat transfer by radiation and convection."

## SOLAR RADIATION

In summer, considerable radiation from the sun is absorbed by buildings, because the outer surfaces of most roofs and walls have high absorptivity.

Much of this radiant energy absorbed from the outside turns into heat, which flows by conduction through the solid material to the cooler inside surfaces of the roof and wall. The radiation *inward* from those inside surfaces, across building spaces, of invisible infra-red heat rays, is considerable, because these surfaces usually have over 90% emissivity.

**Black** non-metallic surfaces such as asphalt, slate, paint, paper, etc. are poor insulators against heat rays in either case, outside or inside; with 85% to 98% absorptivity for solar radiation, and 90% to 98% in enclosed spaces.

Aluminum paint or gilt paint, while it lasts, has a radiant heat absorption and emissivity of 40% to 60% in *enclosed spaces*. It performs better *outdoors*, with only 30% to 50% absorption for direct solar radiation. 1955 ASHAE GUIDE, p. 95.

White paint, whitewash, white tile, white brick and plaster perform well *outdoors*, with an absorptivity for solar radiation of only 30% to 50%. But they perform very poorly in *enclosed spaces*, no better than black paint, with an absorptivity and emissivity of 85% to 95%. 1955 ASHAE GUIDE, p. 95.

Brick of any color, and concrete, in enclosed spaces, have an absorptivity and emissivity of 85% to 95%. But for solar radiation outdoors, red brick and concrete have an absorptivity of 65% to 80%; while yellow and buff brick have 50% to 70% absorptivity.

One reason for this difference between indoor and outdoor absorptivity and emissivity is that in addition to the infra-red heat-rays of frequencies or wave lengths corresponding to those found at ordinary building air space temperatures; the sun emits heat rays of frequencies or wave lengths corresponding to a broad range of *other* temperatures. The sun also emits other rays, visible and invisible. All these rays, with heat-rays predominating, engender a certain amount of heat when they strike a surface and are absorbed, for example by the outer surface of the roof or wall of a building.

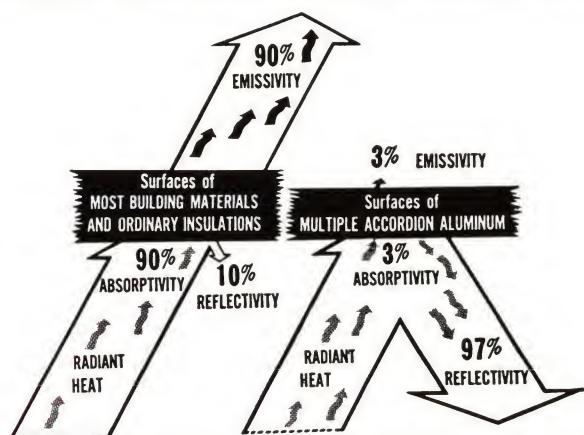
There is also sky or diffuse radiation from the surrounding atmosphere, also from buildings, trees, etc.

Enclosed building spaces are usually without light. Everything is dark and colorless. Radiation between surfaces in such space is limited largely to invisible, infra-red heat-rays.

## MATHEMATICS IN RADIATION

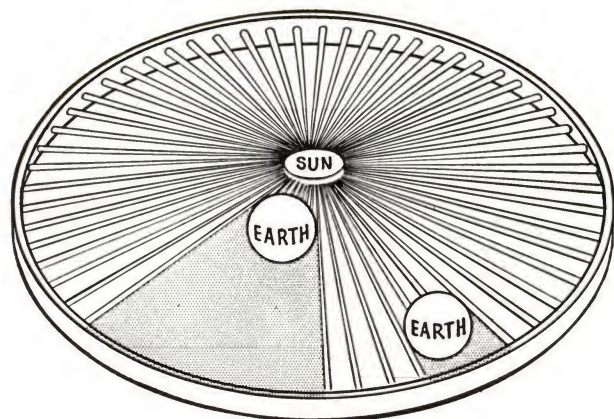
It is our good fortune that there are two natural factors which intrude on the processes of radiation from the sun to the earth, and the absorptivity of its infra-red heat rays. They prevent us from being consumed by the sun's burning energy waves. One factor is the absorption of about a third of the rays which would otherwise reach us, by the atmosphere surrounding the earth.

The other is the operation of the well-known **Inverse Square Law** which describes mathematically how the intensity of radiation is lessened in traveling through space. This stems from the fact that *every point* of a surface radiates in *every direction*. It is not that the strength of the *individual* ray is lessened by distance; but that the *number* of rays which are *intercepted* is less. *EACH* ray travels with undiminished energy, regardless of distance, short or great.



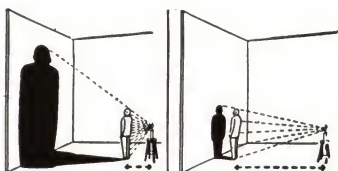
†J. Ralph Dalzell, B.B., Head Architectural and Engineering Dept., and James McKinney, Educational Director of American School. Publishers, American Technical Society, Chicago, U.S.A.



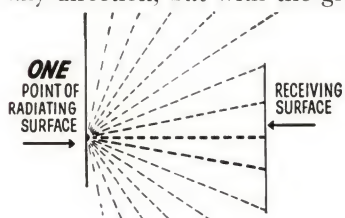


Imagine that a *point of a surface* is the sun, and picture the sun as the hub of a wheel, with the heat rays as the spokes (*see illustration*). Then it can be seen that the closer to the sun (hub, point) a body is, the more rays (spokes) it will intercept. If the Earth were closer to the sun, say as close as the planet Mercury, it would receive many more rays than it does now. The intensity of radiation would be so great that life as we know it could not survive.

An analogy with *light* rays instead of *heat* rays might be more familiar and also illustrative. We have all seen the difference in the amount of light rays which a body intercepts when it is close to the source of light, and the smaller amount when the same body is further distant from the same source of light.



Since *every* point of a surface emits invisible infra-red heat rays, which travel away from that point in a straight line in any direction, but with the greatest intensity perpendicular



to the surface, decreasing to zero intensity parallel with the surface; one might illustrate emission from *one* point (of all the countless points of a surface) as herewith.

The intensity (or energy per second per unit area) of the flow of infra-red heat rays from a point source on a surface which is emitting radiation, to a receiving surface, varies *inversely* as the square of the distance between the source of radiation and the surface which absorbs the rays.

Precisely, the law states that the intensity of radiation on a receiving surface is in proportion to the inverse of the square of the distance from the source, or mathematically,

$$I = \frac{B}{r^2}$$

where  $\begin{cases} I = \text{the intensity of radiation} \\ r = \text{the distance between the bodies} \\ B = \text{a constant of proportionality} \end{cases}$

But when discussing radiation in this booklet, we need not dwell upon great distances such as the millions of miles from the sun to the earth. For *every surface of every object* exposed to space is *continually radiating*, emitting heat rays

*each* of which travels with undiminished energy until it reaches another surface whether it is near or far away. The ray is then generally either absorbed or reflected (in a very few cases transmitted).

The Inverse Square Law plays a negligible part in radiant heat transfer across building spaces, because the radiating and receiving surfaces are parallel and in close proximity. Therefore essentially all the rays emitted from one of the surfaces in such space reach the facing surface; unless some material is introduced into the space to interfere.

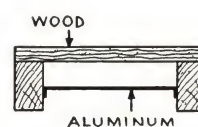
The transmission of heat by radiation varies as the difference of the fourth powers of the *absolute temperatures* of the radiating and receiving bodies. ("Absolute temperature" is 459.7° plus Fahrenheit temperature.)

Referring back to the absorption of *some* of the sun's rays by the Earth's atmosphere, which saves us from being burned up by them; this absorption by the atmosphere also saves many of us who live in the cooler regions, and probably all of us, from being frozen to death at night. Although in connection with heat flow by Conduction through building spaces, the low density of air has special significance; actually the atmosphere of dust particles, vapor and gases surrounding the Earth absorbs sufficient heat rays from the sun to keep us tolerably warm, even during the time the sun is not shining on us and on the atmosphere around us.

#### SUN'S RAYS HAVE NO TEMPERATURE

The sun's rays themselves have no temperature while traveling only through space. Their absorption by the surface of the Earth would create warmth *only in the Earth*. It is the absorption of the energy rays by the surfaces of the *dust particles in the air* and their conversion into heat, which helps keep the atmosphere we live in bearably warm. This radiation to the dust particles flows principally from the sun. But there is also some radiation from the earth to these particles, and in the warmer regions, from the earth to the people. There is even conduction in the warmer regions to people's feet. But in the cooler regions, or during cold weather anywhere, or in a cold-storage plant, etc., there is loss of heat by people not only by radiation to Earth, but also by conduction *from* the warmer feet to the colder earth. *See CRAWL SPACE illustration, page 28.*

That is one reason why floors should be insulated in the colder regions. Where this has not been done, a good and inexpensive make-shift in factories, offices, etc., is a wooden platform 1" or 2" in height, with a sheet of aluminum in the center of the space.



Occupants can stand on this platform while at work, or place their feet on it while sitting. It is effective against heat flow by conduction, because air spaces are very poor conductors, and even the wood is not a good conductor. But it is effective against heat loss by *radiation*, also; because the spaced aluminum sheet is effective in reflecting back most of the heat rays which reach it.

#### MEAN TEMPERATURE, TEMPERATURE DIFFERENCE

In addition to emissivity, the *temperature DIFFERENCE* between the two surfaces which bound an air space, plays an important part in heat flow by radiation. So does increase or decrease in mean temperature, but not in the case of reflective insulations.

An increase in temperature of a surface results in emission



of more rays from *each* and every point of that surface, with many of the rays having a higher frequency and greater energy than those emitted at the lower temperature.

ASHAE 1954 GUIDE, page 178: "The radiation portion of the coefficient is affected by the difference in temperature between the boundary surfaces and by their respective emissivities and is practically independent of depth."

MEAN TEMPERATURE AND TEMPERATURE DIFFERENCE are terms often used in connection with air spaces and insulation. To illustrate, if a space has a temperature of 70° F. on one side, and on the other side 10° F., it

has an average or *mean temperature* of 40° F. It has a temperature *difference* of 60° F. between the 2 sides or surfaces.

Prof. Wilkes, Hechler, and Queer, of M.I.T. and Penn State College state on page 120 of their booklet "Thermal Test Coefficients of Aluminum Insulation for Buildings",\* published by the American Society of Heating and Air Conditioning Engineers,

"For most insulating materials the conductance increases with mean temperature. That this is not the case for reflective insulation is shown in Fig. 7 . . ."

The greater the temperature difference between two surfaces, the greater the difference in the net flow from the

## RADIATION TABLE

### Emissivity, Absorptivity and Reflectivity of Surfaces

| SURFACES<br>at 70°-100° F. |                           | Emissivity and<br>Absorptivity | Reflectivity | Authority                  |
|----------------------------|---------------------------|--------------------------------|--------------|----------------------------|
| ALUMINUM                   | Foil                      | .02 to .05                     | .95 to .98   | Critical Table             |
|                            | Polished                  | .02 to .045                    | .955 to .98  | Natl. Bureau of Standards  |
|                            | Al. Paint                 | .40 to .65                     | .35 to .60   | E. Schmidt                 |
| ASBESTOS                   | Board                     | .96                            | .04          | E. Schmidt                 |
|                            | Paper                     | .93                            | .07          | E. Schmidt                 |
| ASPHALT                    |                           | .90 to .98                     | .02 to .10   | ASHAE Guide                |
| BRASS                      | Natural Surface           | .06 to .07                     | .93 to .94   | E. Schmidt                 |
|                            | Polished                  | .05                            | .95          | E. Schmidt                 |
| BRICK                      |                           | .93                            | .07          | E. Schmidt                 |
| CHROMIUM Polished          |                           | .08                            | .92          | Natl. Bureau of Standards  |
| CONCRETE                   |                           | .85 to .95                     | .05 to .15   | ASHAE Guide                |
| COPPER                     | Polished                  | .04                            | .96          | Natl. Bureau of Standards  |
|                            | Oxidized black            | .78                            | .22          | E. Schmidt                 |
| ENAMEL, white              |                           | .92                            | .08          | E. Schmidt                 |
| GLASS, polished            |                           | .95                            | .05          | E. Schmidt                 |
| GOLD                       |                           | .02                            | .98          | Natl. Bureau of Standards  |
| ICE                        |                           | .96                            | .04          | E. Schmidt                 |
| IRON                       |                           | .242                           | .758         | E. Schmidt                 |
|                            | Polished                  | .06                            | .94          | Natl. Bureau of Standards  |
|                            | Rusty                     | .85                            | .15          | Natl. Bureau of Standards  |
| MARBLE, polished           |                           | .931                           | .069         | E. Schmidt                 |
| MONEL metal, polished      |                           | .02 to .05                     | .95 to .98   | ASHAE Guide                |
| NICKEL                     |                           | .11                            | .89          | E. Schmidt                 |
|                            | Polished                  | .06                            | .94          | E. Schmidt                 |
| OIL, on polished metal     |                           |                                |              |                            |
| Very thin                  |                           | .06                            | .94          | E. Schmidt                 |
| .001" thick                |                           | .27                            | .73          | E. Schmidt                 |
| .002" thick                |                           | .46                            | .54          | E. Schmidt                 |
| .005" thick                |                           | .72                            | .28          | E. Schmidt                 |
| PAINT                      | Ordinary, including White | .85 to .95                     | .05 to .15   | ASHAE Guide                |
|                            | Aluminum, Gilt or Bronze  | .40 to .60                     | .40 to .60   | ASHAE Guide                |
|                            | Whitewash                 | .85 to .95                     | .05 to .15   | ASHAE Guide                |
|                            | Varnish                   | .89                            | .11          | E. Schmidt                 |
| PAPER                      | White                     | .94                            | .06          | E. Schmidt                 |
|                            | Roofing Paper             | .91                            | .09          | E. Schmidt                 |
| PLASTER                    |                           | .93                            | .07          | E. Schmidt                 |
| PORCELAIN                  |                           | .94                            | .06          | E. Schmidt                 |
| SILVER, polished           |                           | .01                            | .99          | Natl. Bureau of Standards  |
| SLATE                      |                           | .90 to .98                     | .02 to .10   | ASHAE Guide                |
| STEEL                      | Polished                  | .07                            | .93          | Natl. Bureau of Standards  |
|                            | Rusty                     | .80                            | .20          | E. Schmidt                 |
|                            | Sheet, polished           | .20                            | .80          | Am. Soc. Refrig. Engineers |
| TILE, white                |                           | .85 to .95                     | .05 to .15   | ASHAE Guide                |
| WATER                      |                           | .96                            | .04          | E. Schmidt                 |
| WOOD                       |                           | .90 to .92                     | .08 to .10   | E. Schmidt                 |



warmer surface to the colder surface, particularly since the variation is with the difference of the *fourth* powers of their absolute temperatures.

However, the less the temperature difference, the more marked the *decrease* in net flow. This explains why *parallel* sheets of reflective surfaces creating *multiple reflective spaces*, result in increasing insulation values for each space, for what might be termed a law of increasing returns. See page 30, under heading, "A Law of Appreciating Returns."

The transmission of heat by *Radiation* across a space bounded by two surfaces increases as the mean temperature of the space increases, even though temperature difference between the two surfaces remains the same. That is because the hotter a surface becomes, the more heat rays will it give off per unit of time and this is out of proportion to the increase in temperature.

According to the **Stephan-Boltzmann Law** applied to the ideal case of a "black body" (a perfect radiator or absorber), heat rays will be emitted at an intensity in proportion to the 4th power of the temperature, or

$$I = AT^4$$

where  $\begin{cases} I = \text{Intensity of Radiation} \\ A = \text{Constant} \\ T = \text{Absolute Temperature} \end{cases}$

In Housing and Home Finance Agency Research Paper 32\*, prepared by the National Bureau of Standards, the value for  $h_r$  is presented to partially describe a coefficient for heat transfer by radiation across a plane air space, as follows:

$$h_r = \frac{0.172 \times 10^{-8}(T_1^4 - T_2^4)}{(T_1 - T_2)}$$

where  $T_1$  and  $T_2$  are the absolute temperatures of the bounding surfaces, and  $(0.172 \times 10^{-8})$  is a constant value.

Let us, for an example, assume that two wall surfaces facing each other across a building air space are at 0° F. and 20° F. and that they are subsequently raised to 100° F. and 120° F. respectively. Substituting the *absolute* temperatures

in the above formula in the two cases, we find

$$(1) \quad h_r = \frac{0.172 \times 10^{-8}(480^4 - 460^4)}{(480 - 460)} = 0.713$$

$$(2) \quad h_r = \frac{0.172 \times 10^{-8}(580^4 - 560^4)}{(580 - 560)} = 1.270$$

Notice that though the temperature difference is the same in both cases, the result is a good deal larger in the second case where mean temperature was 100° F. higher.

To finally determine the radiation coefficient, or the heat actually transferred across an air space by radiation in Btu, per hour, per square foot, per degree F., the above result is multiplied by a factor 'E' called by the National Bureau of Standards "effective emissivity of the space."

The value of 'E' is about .85 for spaces where both bounding surfaces are ordinary material. E is about .05 for spaces having one of the bounding surfaces of a low emissivity material such as aluminum. This means that the very large amount of heat transferred across an ordinary air space by radiation, is *reduced by about 94%* when one of its surfaces is made highly *reflective* to infra-red heat radiation.

Further, it can be seen that the previously mentioned effect of variation in air space efficiency with mean temperature becomes reduced to *relative insignificance upon making one surface reflective*. The radiation coefficients or heat flow by radiation for the two cases shown above with one surface reflective, are

$$(1) \quad E h_r = (.05)(0.713) = .0357 \text{ Btu.}$$

$$(2) \quad E h_r = (.05)(1.270) = .0635 \text{ Btu.}$$

The difference in this case for 100° F. change in mean temperature, is only .0635 Btu less .0357 Btu, or 0.028 Btu, or about 3 one-hundredths of 1 Btu.

The 1954 Heating and Ventilating Guide, page 169, contains a chart which shows a "Typical variation of thermal conductivity with mean temperature" for ordinary insulations.

## U. S. AIR FORCE CRASH FIRE FIGHTERS DEMONSTRATE:

RADIATION DOMINATES HEAT FLOW IN AIR SPACES,  
AND METAL SURFACES HAVE LOW ABSORPTIVITY OF  
HEAT RAYS

Infra-red heat rays travel through space, including icy-cold air, in every direction, up, down, sideways, from warm to cold. They engender no heat until absorbed by a surface.

A news release from Wright Patterson Air Force base says of the accompanying photograph:

"In the center the 'bunkin' suit, now in use by airplane crash fire-fighters, has become too hot for its wearer and is being wet down. The aluminum foil laminate suit at the left, developed by AMC's Aero-Medical Laboratory, was found to give its wearer the greatest comfort and protection and suffered least damage during the test. The foil reflects the extreme heat and helps the wearer retain a relatively low body temperature while fighting airplane crash fires."



"The Air Force crash entry suit consists of multiple layers of metallic foils and high-temperature-resisting conductive insulation, and is designed to provide adequate protection up to an exterior temperature of 2000°F."

From a letter by  
COL. E. J. KENDRICKS, Medical Corps (USAF),  
Chief, Aero-Medical Laboratory, Engineering Division



Profs. Allcut and Ewens of the University of Toronto School of Engineering Research made many tests of such variations. The following four, taken from page 37 of their booklet, "*Heat Insulation as Applied to Buildings and Structures*," show a variation up to 50% with varying mean temperatures and temperature differences.

*"Specimens packed in wooden box with plywood sides."*

|                                  |       |       |       |       |
|----------------------------------|-------|-------|-------|-------|
| Mean temperature, °F .....       | 59.74 | 71.21 | 74.63 | 87.08 |
| Temperature difference, °F ..... | 29.00 | 44.38 | 60.21 | 76.72 |
| Conductance "C" .....            | .0994 | .1137 | .1320 | .1482 |
| Conductivity "k" .....           | .397  | .455  | .528  | .593" |

In his 1949 booklet, "*Thermal Conductivity Tests and Results*," Prof. Allcut on page 13 states, "The fundamental characteristic of most insulating materials is that they contain pockets of air, and depend mostly upon these air pockets for their insulating value. Thus it can be expected that the variations in their thermal conductivities will be closely related to the corresponding variation in air, although they will also be influenced by the nature and the macroscopic structure of the material itself. This conclusion is supported by the fact that virtually all insulating materials have increasing conductivities with increase in mean temperature, the same type of change as that shown by air."

### REFLECTION CAN OCCUR ONLY IN SPACE

Reflection and Emissivity by surfaces can occur **ONLY** in **SPACE**. (Without space *between* surfaces, there would be direct contact between solids, and heat flow would be by *conduction only*.)

When a reflective surface of a material touches a ceiling, floor or wall, *that particular reflective surface* ceases to have radiant insulation value *at the points in contact*.

Therefore care must be exercised when installing **ANY** reflective insulation, that it be stretched sufficiently to **INSURE** that **INNER** air spaces are properly opened up; and that metal does not touch metal. Otherwise **CONDUCTION** through solids will result.

To the extent that inner and outer reflective spaces and ordinary air spaces are eliminated because of *faulty installation*, insulation values will be reduced. In order to function as insulation, aluminum surfaces **MUST** be bounded by air spaces. To *guarantee* this, the use of accordion aluminum

sheets is suggested. They are commercially available with fiber partitions placed so as to automatically **CREATE** multiple rows of **INHERENT**, reflective air-cells. This not only **ENHANCES** insulating value, but **PREVENTS FOIL FROM TOUCHING FOIL** and the Conduction which would otherwise result.



*Try this experiment.* Write us for a free sample of multiple accordion aluminum insulation. Hold it close to your cheek, without touching. Usually the metal is cold enough so that the predominant flow of infra-red rays is from the surface of your face to the surface of the metal. Yet instead of feeling cool, your cheek will soon feel warm. *The explanation:* the Emissivity or rate of heat radiation of the surface of your face, like that of the surfaces of ordinary materials, is over

90%. The Absorptivity of multiple accordion aluminum surfaces is only 3%. It reflects back the rays at a 97% rate. The speed at which the rays travel both in radiation and reflection **from** and to your face is 186,000 miles per second. The Absorptivity of your face, like that of surfaces of ordinary materials, is over 90%. When these reflected rays are absorbed by your face, their energy is converted to heat.

The very same thing occurs when fuel heat tries to escape in winter **FROM** a house insulated with multiple accordion aluminum and also when heat tries to **ENTER** in summer.

*Another experiment.* Place a piece of multiple accordion aluminum above a heat bulb or a warm surface, as shown in this booklet on page 48. Place your fingers **INSIDE**, above the bottom aluminum sheet and *between* it and the fiber. Feel first the warm aluminum surface *below*. Then feel the cooler fiber directly above. Even when warm, aluminum radiates at a *low* rate, has a low emissivity.



*DEMONSTRATOR is unconcerned by roaring flames as he rescues dummy from behind wheel of auto. Flexible material is as light as ordinary suit and coat.*

### FIRE FIGHTING SUIT WITHSTANDS TEMPERATURES OF 2,500° F.

Sunday's N. Y. News, Feb. 6, 1955, showed the new Fire Fighting Suit in action. It was reported to withstand temperatures up to 2,500° F. The suit was made with flame-resistant fabrics and metallic layers covered with aluminum.

They said the new suit "works on the principle of heat reflection. Because of its aluminum foil surface, 95% of the heat bounces off. What's equally important, temperatures inside the suit remain normal. . . ."



# REFLECTIVE SPACES

A space which is bounded by at least one surface which is highly reflective to heat rays, is called a reflective space.

## SURFACE NOT FACING HEAT ALSO EFFECTIVE

In Close's book, "*Building Insulation*," page 102, we find, "As far as the rate of heat transfer across an air space is concerned, it makes **NO DIFFERENCE** whether the reflective surface is on the **COOLER** or warmer side of the space."

One sheet of aluminum in the **CENTER** of an air space creates 2 reflective air spaces and thereby has **TWO** efficient reflective surfaces at the *same time*, regardless of the direction of heat flow. The surface which faces the flow of heat *absorbs* radiation at a rate of but 3%, reflecting it back at a 97% rate. *Simultaneously and independently*, its *other* surface *emits* heat rays at only a 3% rate.

Each full reflective *space*, in upward heat flow, is equivalent to about  $\frac{2}{3}$ " of ordinary insulation. For upward heat flow, the two surfaces of **ONE** sheet of aluminum together with the **TWO** reflective spaces which they face, have a combined efficiency equivalent to more than 1" of ordinary insulation. To obtain still better results, *additional* reflective air spaces must be added.

For example, suspending in space 5 sheets of aluminum 1" apart; or 3 sheets of aluminum separated by 2 sheets of fiber, all spaced 1" apart; creates *six* reflective *spaces*, the thermal equivalent of over 4" of ordinary insulation for upward heat flow and more than 9" for downward heat flow.

## 1 SURFACE IN 1 SPACE

Another important phenomenon is that a second aluminum surface bounding the **SAME** air space has little insulation value. **ONE** aluminum surface in a space has about 3% emissivity or 97% reflectivity against radiation, leaving but a small potential for a second such surface in that space.

Bulletin No. 19, Technical Notes No. 43 of the *National Housing Agency*, based on information furnished by the National Bureau of Standards, states on page 2:

"When any air space is faced with two reflective surfaces the resistance will be equal to those shown for one reflective surface plus 5%."

That is the reason why, with very little reduction in insulation value, 6 reflective spaces are being prefabricated *economically* into multiple accordion insulation, with only 3 sheets of aluminum (instead of 5), plus 2 sheets of *less expensive* fiber. **EACH** of the **SIX** aluminum surfaces of the 3 sheets has 97% reflectivity and only 3% emissivity, and there is but **ONE** such aluminum surface in *each* air space.

## 50% TO 93% HEAT FLOW BY RADIATION

Depending on direction of heat flow (because of the varying role Convection plays in the transfer of heat across building spaces), Radiation is responsible for 50% to 93% of all such heat flow.

## WALL AND ROOF SPACE HEAT FLOW

Walls and roofs are built with air spaces. This minimizes heat flow by Conduction thru solids. Conduction is only about 5% to 7% of all heat flow in any direction through such air space, because air has slight density. Convection currents account for about 15% to 28% of such heat flow across wall spaces, up to 45% for up-heat flow in ceiling and roof spaces, and practically zero for down-heat flow.

## THE AUTHORITIES SAY

All authorities agree that 65% to 80% of the heat that passes across the space from the warm wall to the colder wall, summer and winter, is radiant heat. So an important problem is to decrease radiant heat flow (and to a less extent also convection) across this air space.

Paul D. Close says on page 106 of "*Building Insulation*" that "such radiant heat transfer may vary up to 70 per cent or more in the case of air spaces."

Prof. E. R. Queer, of Penn. State College, in a paper entitled "*Importance of Radiation and Heat Transfer Through Air Spaces*,"\* published by the American Society of Heating and Air Conditioning Engineers, states:

"Heat is transmitted across confined air spaces by radiation, convection and conduction."

"It has been generally supposed that most of the heat lost through air spaces of building structures was by conduction and convection. However, this is not the case; most of the heat transferred between conventional building materials is by radiation."

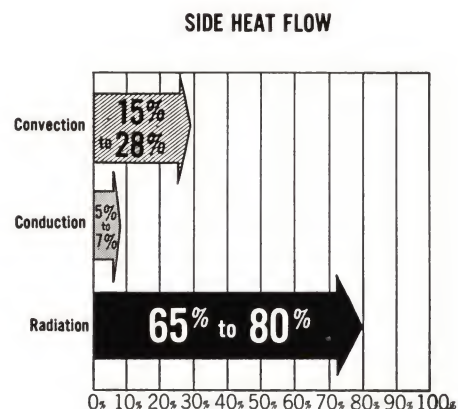
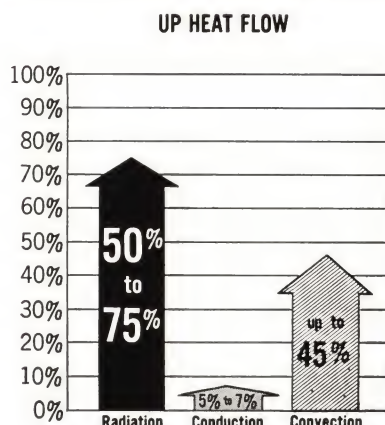
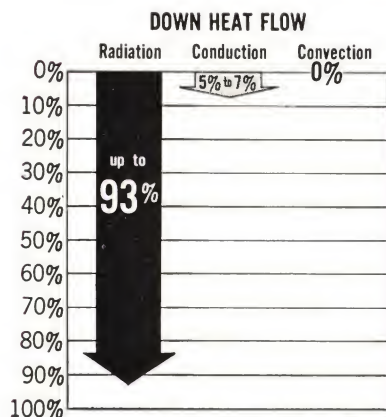
"Approximately 75 percent of the total heat transfer is by radiation."

Dr. J. L. Finck, director of the Finck Laboratories, Brooklyn, New York, formerly with the U. S. Bureau of Standards, stated in the Jan. 1935 issue of *The Architectural Record*:

"It is an experimental fact that, of the total heat transferred across an air space, from 50 to 80 percent is transferred by radiation."

## PERCENTAGE OF HEAT FLOW ACROSS BUILDING SPACES

BY RADIATION, CONDUCTION & CONVECTION





## MODIFYING AND CONTROLLING HEAT FLOWING BY RADIATION, CONVECTION AND CONDUCTION

L. W. Schad, research engineer of Westinghouse Electric Co., gives estimates for radiant heat flow across wall spaces which are most conservative, namely 65%; while other authorities vary up to 80%. (This might be partly accounted for by the fact that in Mr. Schad's tests, the temperatures of the hot and cold surfaces were 212° and 32° F., or a difference of 180° F.; whereas in many other tests and in actual building situations, the temperature difference does not often exceed 70° F.) The following quotation is from his booklet *"Insulating Effect of Successive Air Spaces Bounded by Bright Metallic Surfaces,"*\* published by the American Society of Heating and Air Conditioning Engineers. (Note high temperatures used):

"The value of air spaces as thermal insulation is often discussed without reference to the character of inclosing walls. The character of bounding surfaces greatly affects the amount of energy transferred by radiation which is the only way of modifying the total heat transferred across a given air space. The importance of radiation is often overlooked, especially in problems involving ordinary room temperatures . . ."

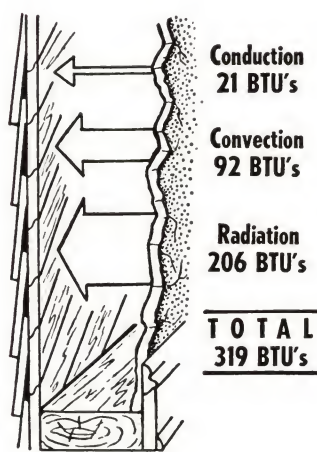
"The following examples will illustrate the use of these equations and at the same time show how much the transfer across a given air space may be modified. The distance between the hot and cold walls is 1 1/2 in. and the temperatures of the hot and cold surfaces are 212° and 32° F., respectively. In Case 1 the inclosing walls are paper, wood, asbestos or other similar material having a radiation constant of approximately 0.9, while in Case 2 the walls are bright metal with a radiation coefficient of 0.15. In Case 3 two bright metal screens are used thus dividing the inclosure into three 1/2-in. spaces."

"BTU TRANSFERRED PER HOUR PER SQUARE FOOT  
BY CONDUCTION, CONVECTION AND RADIATION"

|                  | Case 1 | Case 2 | Case 3 |
|------------------|--------|--------|--------|
| Conduction ..... | 21     | 21     | 23     |
| Convection ..... | 92     | 92     | 23     |
| Radiation .....  | 206    | 20     | 7      |
| Total .....      | 319    | 133    | 53     |

### SOME WALL SPACE HEAT FLOW TESTS

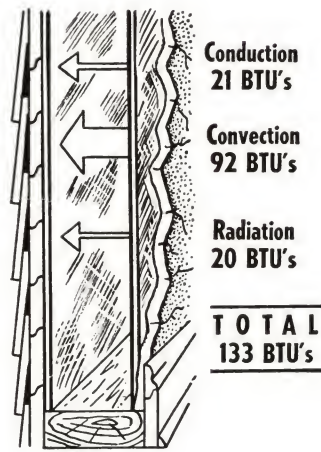
Based on above figures from ASHAE booklet, \**"Insulating Effect of Successive Air Spaces Bounded by Bright Metallic Surfaces."*



**CASE 1**

Uninsulated wall space

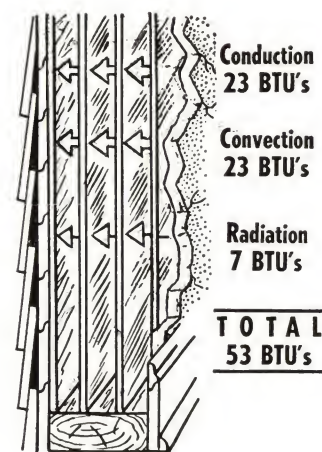
**CASE 1: — Uninsulated wall space.** The surfaces of ordinary building materials have an emissivity of more than 90%, and a heat ray absorption rate of over 90%. Air has low density, so Conduction through wall space is slight, only 21 BTU's. There is nothing to block convection, by which are transferred 92 BTU's. Note: 206 BTU's out of total 319 BTU's going across this wall space was Radiation, or 65% of the total flow of heat.



**CASE 2**

Inner surfaces lined with 15% emissive metal

**CASE 2: — The same wall space** except that inner surfaces were lined with sheets of metal of 15% emissivity and absorptivity. (Aluminum foil has only about 3% emissivity and absorptivity.) Note drastic drop in heat flow by Radiation, from 206 BTU's to 20 BTU's. Conduction (the same air space), remains the same. With nothing to retard or block its passage, Convection remains the same. (Conduction and Convection are not affected by emissivity.) Original total of 319 BTU's dropped to 133 BTU's.



**CASE 3**

2 sheets of 15% emissive metal make 3 reflective spaces

**CASE 3: — Two sheets of 15% emissive metal** divide the wall space into 3 reflective spaces. (Prefabricated multiple aluminum insulation is available with 4 and 6 reflective spaces.) Heat loss by Radiation dropped to 7 BTU's against original 206 BTU's, or 94%. The 2 sheets block Convection so that its flow fell from 92 BTU's to 23 BTU's, or 75%. Conduction rose insignificantly, only 2 BTU's; from 21 to 23 BTU's, despite the presence of all that metal, because they were separated by low density, low conductive air spaces. The total flow in BTU's dropped 85%, from the original 319 to 53 BTU's.



# DOWN HEAT FLOW

Because of the absence of Convection, there is considerable difference in the Conductance even of an ordinary air space for down heat flow, as compared to up and side flow.

Horizontal air spaces of  $3\frac{3}{8}$ " depth, having boundary surfaces of .83 emissivity, were reported by Profs. Wilkes and Peterson in the 1954 ASHAE Guide, Page 178, to have values for upward heat flow of C 1.32; vertical spaces (wall, sideways) a value of C 1.17; and horizontal spaces with heat flow downward, a value of C .94.

The reduction in heat flow through space, where at least one bounding surface has low emissivity and high reflectivity, has already been shown to be considerable with upward and sideward heat flow, as compared to a space with highly emissive bounding surfaces. But the reduction for downward heat flow is even more drastic.

WHY? Because there is no Convection downwards. Heated air, being lighter, *rises* when displaced by colder, heavier air. Since Conduction flow through air is slight, in downward heat flow there is essentially *only* radiation to contend with, and aluminum surfaces reflect it back at a 97% rate.

In Vol. 31, page 824 of *Industrial and Engineering Chemistry*, Dr. J. L. Finck states:

"Let us now consider the heat transfer between two plane parallel surfaces. If the surfaces are horizontal, with the hot surface over the cold surface, there will be no convection, only conduction and radiation. In all other positions we will have all three modes of heat transfer."

Prof. G. B. Wilkes of the Mass. Institute of Technology and Prof. E. R. Queer of Penn. State College Experiment Station, state in their booklet, "*Thermal Test Co-efficients of Aluminum Insulation*,"\* published by the American Society of Heating & Air Conditioning Engineers:

"For reflective insulation orientation must be considered. An unusually low heat-transfer value is obtained with the heat flowing down. This is particularly striking in the horizontal positions. . . . In these cases the major portion of the heat transfer is by conduction while radiation and convection are a minimum. . . ."

*Progressive Architecture*, Nov. 1949, page 76, states,

"The heat storage capacity of reflective insulation is low. As a result, it does not store heat during summer days, only to pass it on down into the rooms of the house from the attic at night when coolness is most apt to be desired from the point of view of sleeping comfort.

"The conclusion from these various facts is that, at least as far as present knowledge goes, reflective insulation is one of the essentials for a weather-conditioned house in a region that has hot summers."

Prof. Gordon B. Wilkes in an article "Reflective Insulation" appearing in *Industrial and Engineering Chemistry*, Vol. 31, No. 7, Page 832, states, "The heat capacity of aluminum foil, as installed, is about one-fortieth that of an insulating material weighing 8 pounds per cubic foot."

On Page 833 of the same article Prof. Wilkes states: — "The heat transfer through ordinary insulating materials . . . is primarily by conduction, whereas the heat transfer across an air space with reflective surfaces and an 0.75 inch in thickness is primarily by convection."

But there is no convection *down*, only up and sideways.

## SUMMER COMFORT

The National Bureau of Standards, in its booklet BMS 52\* "Effect of Ceiling Insulation Upon Summer Comfort," lists on page 10 "the insulations tested" in the "order of decreasing effectiveness in protecting the ceiling against summer heat" as follows:

1. Two layers of aluminum foil (both sides of each layer reflecting).
2. Full-thick ( $3\frac{5}{8}$  inches) ordinary insulation.
3. One layer of aluminum foil (both sides reflecting).

For cooling and air-conditioning, some engineers recommend 6" of ordinary insulation in ceilings with 3" in walls, or the equivalent in aluminum and reflective spaces.

The chart, page 31, shows that both 6" and 3" equivalents can be achieved for down and wall heat flow respectively, with 2 sheets of aluminum forming three 1" parallel spaces.

According to a well known authority, the summer heat load on a roof can be reduced from a potential of 19,000 Btu per hour to as little as 600 Btu by proper detailing of a house, including the use of multiple aluminum insulation.

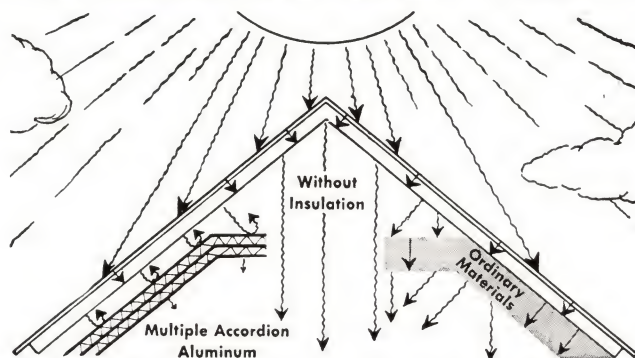
This shield against radiant heat lifts part of the load from house-cooling equipment, reducing installation and up-keep costs. The building *not* artificially cooled, needs it even more!

The August 1953 issue of "House & Home" has a very valuable article by A. M. Watkins entitled "*Five Top Priorities for Designing an Air-Conditioned House*,"\* reprints of which are available from us for the asking.

## An Empty Roof Space Would Be The Best Insulation Against Summer Sun Were It Not For Radiation

To be comfortable in summer you must ward off unwanted heat rays or radiation. Most heat flow through a *roof space* in summer is by radiation. There is no convection down, and little conduction through low density air. Temperatures can reach over 140° F. in some attics.

Ordinary insulation may retard heat for a time, but stores a large amount of heat as compared to empty space. More dense, such insulation is a much better conductor of heat than just air. Its surfaces have a heat ray absorptivity and emissivity of over 90% and radiate heat into the building through the day, and sometimes into the night.



The solution is to use a material which has little substance and whose surfaces will absorb and emit little radiation. Gold or silver foil would be excellent, but tough multiple layers of aluminum, which weigh but  $\frac{1}{4}$  oz. per sq. ft. are inexpensive and almost as good, with a heat ray absorptivity and emissivity of only 3%.



**TRY THIS TEST:** Tack or scotch-tape 3 sq. ft. of multiple aluminum insulation (which will be sent free on request) to the underside of a hot roof or ceiling, whether uninsulated, or insulated with ordinary insulation. Step in and out of the protected area *beneath* the aluminum insulation. The difference will be so marked you will need no thermometer.

## HEAT LOSSES THROUGH CELLARS AND CRAWL SPACES

When walls and ceilings are warm, and *floors are cold*, considerable heat is lost. Obeying nature's law that heat flows from warm to cold in every direction by Radiation and Conduction — the ceilings, walls, furniture, even the dust particles in the air and the people in the room, *radiate* invisible heat rays to the cold floor, which *absorbs* them at a 90% rate.

There is also heat flow *down* by *conduction*, down the walls, and wherever furniture and people touch the floor.

Still obeying nature's same law, the warmth then travels *down* through the floor by *conduction* to the *surface* below. From that surface, which has 90% emissivity, the heat is radiated downward to the ground below, without temperature, to heat Mother Earth.

### GROUND VAPORS

Needed here is a thermal insulation with very low emissivity; which *also* keeps out ground vapors; which is not affected by dampness; which will remain permanently in place and not tear at the points of nailing; and which can be installed cheaply without the need of expensive supports. (*Multiple sheets of aluminum meet these specifications.*)

The 1955 Guide of the Am. Society of Heating and Air Conditioning Engineers states on page 184, "The heat transfer through basement walls and floors to the ground is dependent on the temperature difference between the air within and that of the ground, on the material constituting the wall or floor, and on the conductivity of the surrounding earth."

If scientific, multiple, joist-to-joist aluminum insulation, of full uniform-depth, is installed in ground floors and *crawl spaces* of cold buildings, the heat rays which flow downward in winter will be reflected upward, back to the structure, at a 97% rate. There will be only 3% absorptivity of heat rays. The temperature of the **COLD FLOORS** which cause **COLD FEET** will be raised, and **FUEL BILLS** reduced.

## NO "DEAD" AIR CELLS

There is *no such thing* as a "dead" air-cell, or "dead" air-space, as far as heat flow in thermal insulations is concerned; nor even in the case of a perfectly air-tight compartment.

Except for downward flow, convection currents are inevitable with differences in temperature between surfaces, if air or some other gas is present inside.

Furthermore, since air has *some* density, there would be some heat transfer by conduction if *any* surface of a so-called "dead" air-cell were heated.

Finally, radiation, which accounts for 50% to 93% of the heat transfer, would be present and active in any direction.

Even assuming the space to be a vacuum (in which case it would cease to be an *air-space*), heat rays would pass through freely, as they pass through the many million miles of vacuum between the sun and the earth.

## SURFACE ROUGHNESS INCREASES CONDUCTANCE

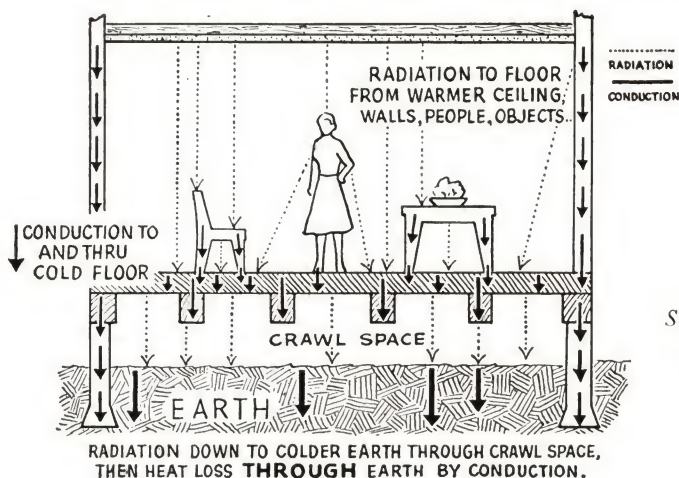
Prof. E. A. Allcut and F. G. Ewens of the University of Toronto, School of Engineering, state in their book "Heat Insulation as Applied to Buildings and Structures," "Surface conductance increases with the roughness of the surface."

The 1955 ASHAE GUIDE, page 174 states, "The heat transfer by convection and conduction is controlled by the roughness of the surface, by air movement and temperature difference between the air and the surface."

In a booklet entitled "Wind Velocity Gradients Near a Surface and Their Effect on Film Conductance,"\* by F. C. Houghten, Director, and Paul McDermott, Research Engineer of the Laboratory of the American Society of Heating and Air Conditioning Engineers, on page 9 we find,

"The smoother surfaces show a lower coefficient for the same wind velocity and a slight curvature."

"The several curves for the different surfaces studied in the two investigations indicate rather clearly that *roughness of surface* is the *main factor* affecting film conductance coefficients for any type of material used in building construction."



## ELIMINATE COLD FLOORS!

CUT FUEL BILLS! INCREASE COMFORT!

By Reducing Down-Heat Flow Through Crawl Spaces

*Scientific Multiple Aluminum Insulation reflects back Radiation up to floor with 97% reflectivity and only 3% absorptivity.*



# AIR SPACE CONDUCTANCES

"The Conductance of an air space is dependent on the temperature difference, the height, the depth, the position and the character of the boundary surfaces," page 167, the 1955 ASHAE Guide.

As far as *direction* of radiant heat flow is concerned, it makes no difference whether the flow is up, sideways, diagonal or downwards. It is otherwise with convection.

Experimental investigations have been made to find out what *width* of air space adjoining ordinary surfaces and reflective surfaces will give the best insulation value, and how this value is affected by changes in mean temperature and temperature differences of the surfaces of the space.

Radiation is found to be practically independent of the depth of a space, but is affected by temperature difference.

Convection and Conduction are affected by depth of air space and temperature difference, but not at all by emissivity. Direction of heat flow affects convection only.

For horizontal heat flow, including heat flow through wall spaces, the conductances of vertical air spaces bounded by ordinary materials decrease as depth of space increases, until a depth of about  $\frac{3}{4}$ " is attained; beyond which depth there is slight change. In other words, the larger the depth of a space up to  $\frac{3}{4}$ ", the better will be its insulating value.

On the other hand, and this holds true whether the direction of heat flow is up, down or sideways, the *smaller* the air space below  $\frac{3}{4}$ ", the greater will be not only the heat flow by Conduction, but also the over-all heat flow or Conductance. The smaller air space is poorer as an insulation. Below  $\frac{1}{4}$ " depth it deteriorates so badly in insulating value that heat flow through the tiny air space follows the curve of *pure conduction*.

We have already noted the great difference in thermal conductance of an ordinary air space with respect to *direction* of heat flow, up, down or horizontal, namely C 1.32, .94 and 1.10 respectively. (Page 18.)

The difference is even more drastic if the surfaces are changed to *highly reflective* ones, changing the air spaces to reflective air spaces, for instance an air space with an effective emissivity of 5%. These spaces then have a C factor of .5 for upward heat flow, .175 for down flow and .357 for horizontal flow. (R factors: — up, 2.0; down, 5.7; side, 2.8.)

Subdividing even a reflective space into several smaller reflective spaces, but not *too* small, produces further very marked decreases in conductance, as the Westinghouse-Schad tests demonstrated. (Page 26.)

## OPTIMUM SPACING FOR ALUMINUM SHEETS

AND VARIATIONS WITH TEMPERATURE DIFFERENCE,  
MEAN TEMPERATURE AND DIRECTION OF HEAT FLOW

### HEAT FLOW SIDEWAYS, Reflective Spaces.

For a *single* reflective space to have lowest Conductance for side or wall heat flow, the optimum width is about  $\frac{3}{4}$ ".

If the space is made *smaller* than  $\frac{3}{4}$ ", but with the same boundary surface temperatures, the amount of Radiation across it remains the same, and Convection decreases. But Conduction through the air space increases so much more that the *net* result is a higher 'C' factor, i.e. more heat flow across. As the width decreases its Conductance increases.

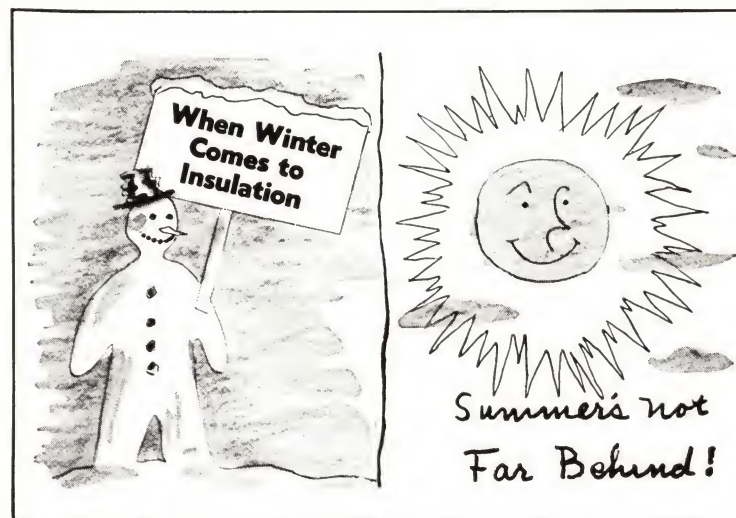
If the space is eliminated, although radiation and convection flow cease entirely, direct conduction between solids results, and even greater heat flow.

It has been estimated that the maximum insulating value, the lowest Conductance, in a space of *fixed* width, for horizontal or wall space heat flow, can be obtained by creating a series of reflective spaces within it, separated about .37 inches apart. Although *each* .37" space has less insulating value than the maximum potential of a single  $\frac{3}{4}$ " space, nevertheless because of the relatively *larger number* of such .37" spaces resulting from the narrower subdivisions, each *reflective* space has a reduced *temperature difference* between surfaces, which reduces convection as well as radiant heat flow. The result is an efficiency which is the maximum possible. This finds important application in problems involving extreme temperature differences, such as sometimes occur in refrigeration and high temperature work.

Decreasing the space between sheets below .37 inches, (and correspondingly increasing the number of sheets) will unduly increase heat flow by conduction through each narrower space, *decrease* the overall resistance, and *decrease* the insulating value of the space to be insulated.

### HEAT FLOW DOWN, Reflective Space Values

If the width of the space is increased up to 8", Conductance will become less, *the greatest decrease occurring in the first inch of space*. There will be a marked difference between 1" and 2", and very little change after 2".



**I**NSULATION for winter warmth and fuel conservation can be very efficient, and also provide coolness and comfort in summer. A building correctly shielded from the summer sun's radiation is considerably cooler, not only by day, but also at night. Protected against winter heat loss and fuel waste, this building warms up faster when there is no great mass of insulating material which also requires heating.

Choosing insulation should be a scientific selection based on physical needs, financial considerations . . . and above all, on performance. The RADIATION TABLE on page 22 shows the heat ray absorptivities, reflectivities, and emissivities of the different materials. It is also important to know their permanency, their permeability to water vapor, and to what extent they foster or retard destructive condensation.



# RECENT IMPORTANT CONTRIBUTIONS

An important contribution to the knowledge of air space values, both reflective and non-reflective, was recently made by H. E. Robinson and F. J. Powlitch, under the direction of R. S. Dill, chief of the Heating and Air Conditioning Section, all with the National Bureau of Standards. Their findings were published by Housing and Home Finance Agency in a booklet entitled "THE THERMAL INSULATING VALUE OF AIR SPACES, Housing Research paper 32."\* Our interpretation of some of the significant material contained in this work, follows.

Apart from orientation, the two factors which have significant effect on the thermal resistance value of reflective air spaces are the *temperature difference* between the bounding surfaces, and the *depth* of the space.

## HEAT FLOW UP, DOWN & SIDE

The insulating value of a reflective space in both the up and down heat flow directions *increases* with *increasing depth* up to about  $3\frac{1}{2}$ ", after which further increase seems to have negligible effect. The greatest part of the insulating value comes in the *first inch* of space. In the side heat flow direction, a maximum insulating effect is obtained with spaces about 1 inch in depth; for greater thicknesses, the insulating value first decreases slightly and then increases very slowly for depths of 2" or more. Except for downward heat flow, the changes of insulating value of reflective air spaces with space depth are less than 15%, for depths greater than about one inch.

Considerably more important is the fact that the insulating value of a reflective space with heat flow in any direction, *increases* markedly as the *temperature difference* between its bounding surfaces *decreases* and causes a significant decrease in convection. It is important because, except for heat flow vertically downward, halving the temperature difference across a space increases its insulating value considerably more than halving its depth may decrease it, provided the final depth is not less than about one inch.

### A LAW OF APPRECIATING RETURNS

For this reason, for heat flowing in the up and lateral directions, successive reflective air spaces, one behind the other, follow a law of appreciating returns.

For example, assume heat to be flowing *up* in a group of 8" ceiling joist spaces, with ordinary fixed boundary temperatures (*see Illustration*). Also assume that the *depth* of the first space is divided in half by an aluminum sheet; that the next space is divided in three parts by two aluminum sheets

centered 1" apart; the next space divided in four parts with three sheets centered 1" apart; the next in five parts with four sheets; and the last in six parts with five sheets.

We will find that the insulating value of *each* of the reflective spaces thus formed, follows a pattern of increase as the number of subdivisions of the joist space increases. In other words, *each* 1" reflective air space where the joist space has been subdivided in six parts, has greater insulating value than each similar 1" space where it has been subdivided in five parts; which in turn has greater value than each 1" space where there are four subdivisions, etc. This means of course, that the total insulating value in an 8" joist space of 6 such reflective air spaces is *more than twice* that of 3 such spaces, *more than 50%* better than 4 such spaces.

The explanation is a lower temperature difference across each subdivided space, where there are more subdivisions.

Assuming a space with a *temperature difference* of any *fixed amount*: — dividing that space into 2 spaces and the temperature difference by 2; or into 4 spaces and the temperature difference by 4; necessarily produces a different and *larger* temperature difference quotient than would a division by 6 or into six spaces. In other words, the more the space is divided, the greater is the *division of the original spread of temperature*; and so **EACH SPACE CARRIES A SMALLER BURDEN OF TEMPERATURE DIFFERENCE**. This means a *decrease* in convection and a corresponding significant increase in the insulating value of the space.

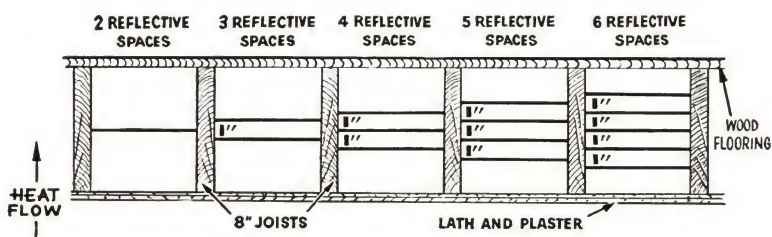
This holds true down to space depths of about 1", below which the diminution in insulating value due to increase in conduction because of lessening the depth, becomes the controlling factor.

A similar type of effect can be noted for lateral heat flow. For vertically downward heat flow this appreciation of value does not obtain.

The C and U values on page 31 were calculated by the author of *this* booklet on the basis of work done by the NATIONAL BUREAU OF STANDARDS as reported in Housing and Home Finance Agency Research Paper 32.\* Structural composition of wall, floor and ceiling and the inside and outside temperatures were assumed the same as those used for typical calculated values by the Bureau of Standards. The ceiling joist space was taken as  $7\frac{5}{8}$ " deep, wall stud space as  $3\frac{5}{8}$ ", and floor joist space as  $9\frac{5}{8}$ ". (For 5 and 6 space side heat flow,  $5\frac{5}{8}$ " stud space was used.) The roof was taken as asphalt shingles or roll roofing on 25/32" solid wood sheathing.

For purposes of calculation, air temperatures were assumed to be as follows:

| Heat flow     | Inside Temp. °F | Outside Temp. °F | Mean Temp. °F | Temp. Diff. °F |
|---------------|-----------------|------------------|---------------|----------------|
| Walls side    | 70              | 0                | 35            | 70             |
| Ceilings up   | 80              | 10 (attic)       | 45            | 70             |
| Ceilings down | 90              | 120 (attic)      | 105           | 30             |
| Floors down   | 65              | 30               | 48            | 35             |





## THERMAL FACTORS FOR PARALLEL REFLECTIVE AIR SPACES

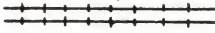
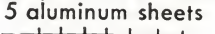
(in Btu's per sq. ft., per hour, per degree F.)

Where dividing media are ALUMINUM with .04 emissivity, spaced 1" apart

Calculated on the basis of work done by the

**NATIONAL BUREAU OF STANDARDS**

For Housing & Home Finance Agency's Research Paper #32

|                                                                                                                               | UP-HEAT     |                                            |                                                 | DOWN-HEAT   |                                            |                                                 |                                       | SIDE-HEAT           |                     |
|-------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------------------------------|-------------------------------------------------|-------------|--------------------------------------------|-------------------------------------------------|---------------------------------------|---------------------|---------------------|
|                                                                                                                               | C<br>FACTOR | U FACTOR<br>Attic Floor<br>(roof excluded) | U FACTOR<br>Ceiling & Roof<br>(unfloored attic) | C<br>FACTOR | U FACTOR<br>Attic Floor<br>(roof excluded) | U FACTOR<br>Ceiling & Roof<br>(unfloored attic) | U FACTOR<br>Floor Over<br>Crawl Space | C<br>FACTOR<br>Wall | U<br>FACTOR<br>Wall |
| 3 REFLECTIVE SPACES<br>2 aluminum sheets<br> | .143        | .107                                       | .102                                            | .043        | .039                                       | .038                                            | .051                                  | .102                | .077                |
| 4 REFLECTIVE SPACES<br>3 aluminum sheets<br> | .105        | .083                                       | .081                                            | .036        | .034                                       | .033                                            | .040                                  | .069                | .057                |
| 5 REFLECTIVE SPACES<br>4 aluminum sheets<br> | .082        | .068                                       | .066                                            | .032        | .030                                       | .029                                            | .033                                  | .051                | .044                |
| 6 REFLECTIVE SPACES<br>5 aluminum sheets<br> | .067        | .058                                       | .056                                            | .029        | .027                                       | .027                                            | .028                                  | .041                | .037                |

## THERMAL FACTORS FOR PARALLEL REFLECTIVE AIR SPACES

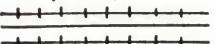
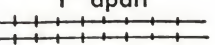
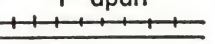
(in Btu's per sq. ft., per hour, per degree F.)

Where dividing media are ALUMINUM with .03 emissivity, and PAPER, spaced 1" apart

Calculated on the basis of work done by the

**NATIONAL BUREAU OF STANDARDS**

For Housing & Home Finance Agency's Research Paper #32

|                                                                                                                                                                | UP-HEAT     |                                            |                                                 | DOWN-HEAT   |                                            |                                                 |                                       | SIDE-HEAT           |                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------------------------------|-------------------------------------------------|-------------|--------------------------------------------|-------------------------------------------------|---------------------------------------|---------------------|---------------------|
|                                                                                                                                                                | C<br>FACTOR | U FACTOR<br>Attic Floor<br>(roof excluded) | U FACTOR<br>Ceiling & Roof<br>(unfloored attic) | C<br>FACTOR | U FACTOR<br>Attic Floor<br>(roof excluded) | U FACTOR<br>Ceiling & Roof<br>(unfloored attic) | U FACTOR<br>Floor Over<br>Crawl Space | C<br>FACTOR<br>Wall | U<br>FACTOR<br>Wall |
| 4 REFLECTIVE SPACES<br>2 aluminum sheets<br>1 paper sheet<br>7/8" apart<br> | .106        | .084                                       | .082                                            | .035        | .032                                       | .032                                            | .039                                  | .069                | .057                |
| 5 REFLECTIVE SPACES<br>3 aluminum sheets<br>1 paper sheet<br>1" apart<br>   | .082        | .068                                       | .066                                            | .031        | .029                                       | .028                                            | .033                                  | .051                | .044                |
| 6 REFLECTIVE SPACES<br>3 aluminum sheets<br>2 paper sheets<br>1" apart<br>  | .067        | .058                                       | .056                                            | .029        | .027                                       | .027                                            | .028                                  | .043                | .038                |



## INFRA-RED HEAT RAYS PIERCE

331 Miles of Dust and Fog

INFRA-RED HEAT RAYS differ from light rays, such as those reflected by a glass mirror. Light rays are visible, and can penetrate only glass, or other transparent or translucent substances.

The infra-red heat rays are invisible. They are largely absorbed by glass mirrors, plaster, wood, brick, etc., but aluminum surfaces **TURN BACK**, *reflect*, most of these heat rays. This kind of "reflection" has no relationship to the visible *brightness* of the aluminum, and the surface may be just as effective against heat rays when the metal is **DULL**, looking as when it is shiny and **BRIGHT**.

Aluminum foil has a reflectivity **ALSO** for *visible light*, of over 80%, and therefore is extensively used **EXPOSED** in factories, auditoriums, etc. It reflects daylight and artificial illumination, and so reduces electric bills.

The American Society of Heating and Air Conditioning Engineers, on page 188 of the Transactions of the 45th Annual Meeting, published a paper by C. S. Taylor and J. D. Edwards, Physical Chemist and Asst. Director of Research of the Research Laboratories of the Aluminum Co. of America, which includes the following:

"The penetrating characteristics of infra-red radiation are illustrated by the aerial photographs which have been taken by Captain Albert Stevens. With infra-red sensitized photographic plates, views of mountains as far as 331 miles distant from the photographer have been taken, though the mountain itself was invisible to the eye because of the intervening haze and fog."

Prof. Wilkes of M.I.T. and Profs. Queer and Hechler of Penn. State College Experiment Station state in "*Thermal Test Coefficients of Aluminum Insulation for Buildings*,"\*

"A mirror, consisting of glass with a silvered surface on the back of the glass, is an excellent reflector of light but it is a very poor reflector of infra-red radiation corresponding to room temperature. In fact, such a mirror would have about the same reflectivity for infra-red as a heavy coating of black paint.



Courtesy of Eastman Kodak Co.

*This composite of ordinary and Infrared photos shows comparative haze penetration of both types of photographic film. Left: ordinary film using visible light radiation, reproduces the haze-covered terrain as it appeared to the naked eye. Right: Infrared film, sensitive to invisible Infrared radiation, reproduces what the eye cannot see, by penetrating miles of haze.*

"With this in view, it is obviously impossible to judge the infra-red reflectivity or emissivity of a surface by its appearance to the eye. Consequently, in a discussion of reflective surfaces for building insulation, the term brightness has no specific meaning. The terms emissivity or reflectivity definitely define the radiating or reflecting power of a surface and values may be determined for the long wave-length radiation corresponding to room temperature."

Close's book, "*BUILDING INSULATION*," page 109 says:

"The visible brightness of a surface is not a gauge of its emissivity, for a surface may appear to have lost its reflective value and yet have a comparatively low emissivity as tested by a radiometer or emissivity-testing instrument."

## PERMANENT IN THERMAL VALUE

Aluminum combines readily with oxygen to form a *non-progressive* oxide of a fixed amount. This means that when a thin coating of *aluminum-oxide* forms, the chemical action stops. A film of this oxide, generally invisible, normally covers the metal. This film *protects* the aluminum from most chemical attack, and is impervious to many reagents. Most important of all, it protects against further attack by *oxygen itself*, which is ever present in the air, slowly burning up or **OXIDIZING**, minerals as well as organic matter.

It is often necessary to mix **ALLOYS** with aluminum, for structural or other purposes, sometimes even at the price of *corrosion*. But aluminum **FOIL** for insulation purposes is made from *unadulterated* aluminum at least 99.4% pure. It is always covered and protected with *aluminum oxide*. It is this type of pure aluminum which is used for making multiple aluminum insulation.

Prof. Wilkes of M.I.T., in Vol. 31 No. 7 of Industrial and Engineering Chemistry, wrote on page 837:

"The author exposed aluminum foil for 30 days in a furnace at a temperature of 1050° F., and to the eye the surface changed to a dull gray; but the emissivity at room

temperature increased only from 0.05 to 0.075 and it still would have made an effective insulator. The conductance value for a vertical air space faced with this gray surface would be only about 5 per cent greater than with new aluminum foil."

One of the few things harmful to aluminum is *actual contact* with **WET** lime. By installing the insulation with an air space on each side, contact with wet plaster, etc. is avoided, and an additional space is formed to enhance insulation value. In any case, if *multiple* sheets of aluminum were used, and there were any contact, only 1 sheet could be affected, leaving considerable insulation efficiency because of the other sheets. Even the sheet in contact would be affected only at the points which actually touched.

Prof. Wilkes stated in his paper\* on the subject,

"In regard to the permanency of the reflective surface, I have no hesitancy in stating that under proper installation conditions, Aluminum Foil Insulation will maintain its efficiency over a long period of time when used as building insulation."



## ACTUAL TESTS

In the American Society of Heating & Air Conditioning Engineers' *Journal Section*, Jan. 1940,\* Prof. Wilkes stated:

"Aluminum foil exposed in a vertical position since 1929 to the dust and fumes in the Heat Measurements Laboratory, M.I.T. Samples of this foil have been removed from time to time and the emissivity determined. Over a period of 10 years no appreciable change in emissivity was found."

"Aluminum-foil-insulated provision chambers of the motor-ship Leverkusen, fitted out in May, 1928. In January, 1934, samples of this foil were removed by representatives of Lloyd's Register of Shipping, Hamburg; they reported: 'The general impression gained as a result of the examination made is that the insulation examined by us is in exactly the same condition as it was five years ago when built into the vessel.'"

"Hundreds of samples of aluminum foil have been stored in the laboratory for various periods of time up to 10 years with no visible signs of deterioration.

"Aluminum foil after two-year exposure to salt spray and moisture on underside of roof of log boat house in Newington, N. H. The foil was spotted with salt that had been left on the foil by evaporation of the salt spray. The emissivity was found to be 0.10."

"Aluminum foil suspended vertically in laboratory for three years and measured with accumulated dust and fume. The emissivity was 0.05."

The National Bureau of Standards, U. S. Dept. of Commerce, in its Letter-Circular-535, states:

"Installations are reported where no appreciable deterioration of the aluminum has occurred over a considerable period of years. Thin layers of dust readily visible to the eye do not cause very serious lowering in the reflecting power." "The appearance of the surface is not a reliable guide as to its reflectivity for radiant heat, and foil which appears dark or discolored may have lost little in insulating value if the surface film is thin."

Aluminum row-boats and canoes by the thousands are in use everywhere.

The United States Rubber Co. states in its 1947 booklet, *"Serving You Through Science,"* on page 5,

"Aluminum is highly Resistant to the effect of corrosion. Aluminum, for instance, is used successfully for hulls of light fast salt-water sailboats. Aluminum is constantly being used where it is exposed to weather, salt spray and other conditions which would adversely affect most metals."

"On an island in Long Island Sound there is still in operation 5 miles of aluminum cable installed in 1899! It has withstood 48 years of weather and salt spray. A recent tour revealed that the cable itself is just as good now as when originally installed."

Further inquiry elicited the following information in a letter from the U. S. Rubber Co. dated March 11, 1948:

"This installation on Fishers Island. This line used for lighting service around the island. A few ragged remnants of the braid still adhere to the wire close to the ties. In many spans all braid is gone. On most of the cable the weatherproofing has long since disintegrated and there is no way of telling how long the wire has been bare."



STEAMSHIP "UNITED STATES"

The S.S. United States is the fastest commercial ship in the world, using more aluminum than any other structure on land or sea. This made the ship light, fast, fireproof, and durable against the salt sea and the salt sea air.

Her lifeboats and even the davits for launching them, are aluminum. So are her giant 55 foot funnels, the largest in the world. About 1,250,000 aluminum rivets were used in her construction. All furniture, and 1200 deck chairs, elevator doors, shower stalls, bathroom fixtures, the wide wings of the outer bridge, the tops of the rails on the weather decks, flower vases in the passenger cabins and coat hangers in the wardrobes, are all made of aluminum.

## PERMANENT AS THE BUILDING ITSELF

Inherent weight, especially when accentuated by moisture, can cause ordinary insulation to pack down and lose some of its insulation value. In their book "INSULATION," Dalzell & McKinney state on page 4:

"Volume dimensions, however, offer a more serious problem, because many loose insulations settle down year by year, producing areas that are eventually without insulation. Thus, it is best to use molded forms of insulation or other forms not likely to settle or change in volume."

Scientific multiple Aluminum Insulation is so light as well as strong, that once installed it stays permanently.

This insulation is constantly light-weight, winter and summer, because the aluminum sheets (which predominate), cannot absorb water to weigh them down. The combination is practically non-condensation forming.

**MOLD AND INSECTS:** Outer wall spaces, also roof and crawl spaces, tend to be damp, even if an impervious vapor barrier protects them from the flow of vapor which develops inside the buildings. Rain and melting snow seep in from the outside. Vapor also flows in, when vapor density outside a building is greater than inside, for instance often on summer mornings, and frequently when a building is air-conditioned. Dampness promotes mold, fungus growth, timber rot, etc.

So as to be permanent, it is best that any paper or fiber used in insulation be mold-resistant.

It should also be insect-resistant so as not to be devoured. Furthermore, insects are unsanitary.

The fiber spacers in *standard* multiple aluminum insulation is both mold and insect resistant. The chemicals incorporated in it are so effective that insects are repelled, even the voracious tropical ant, which will quickly devour almost anything that is organic and unprotected.

The fiber spacers can be depended upon to stay permanently between the aluminum sheets in the structure, insuring *additional* inner reflective air spaces which add to the thermal value and prevent aluminum from touching aluminum.



# A FIRE Started in this School . . . .

## Its Path was Barred by Multiple Accordion Aluminum!



**T**HIS is the New Bridge Elementary School in New Milford, N. J. When it was built, Arthur Rigolo, the architect, had specified standard Infra multiple-layer aluminum insulation, Type 6, and it was installed in the ceilings. (This consists of aluminum and chemically treated Kraft paper.)

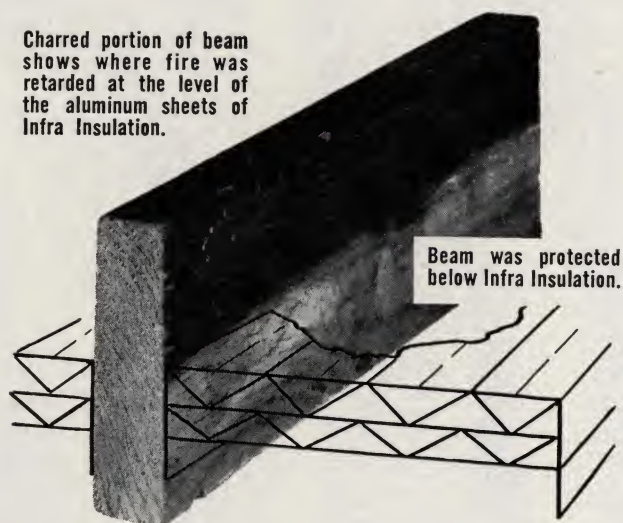
In July 1953, the roof of this school was set on fire from the outside. Most of the roof area ABOVE four classrooms was destroyed, but Infra Insulation protected their ceilings. The fire did not penetrate below the insulation.

The *ceiling beams* were found to have been charred by the fire ABOVE the insulation; but the SAME *ceiling beams* were NOT charred below it.

When the roof area was renovated in August 1953, Infra multiple-layer aluminum insulation was *again* installed between the roof beams.

Fires sometimes spread more rapidly when aggravated by Heat-Rays or Radiation; or because of flow of super-heated air. The surfaces of multiple-layer aluminum have a Heat Ray or Radiation absorptivity and emissivity of only 3%, with 97% reflectivity, whether the heat rays originate in a furnace, a warmed surface or a burning area in a building. Aluminum will not burn. It has a melting point of 1220° F. Even the fiber separators of standard Infra are flame-resistant.

Charred portion of beam shows where fire was retarded at the level of the aluminum sheets of Infra Insulation.



Beam was protected below Infra Insulation.

Photograph of section of ceiling beam removed from New Bridge School when fire damage was repaired.

### FLAME-RETARDANT

For permanency, an insulation should be fire-retardant.

Aluminum sheets spaced from both sides of the paper or fiber are an *additional* protection, because this metal can withstand heat up to 1220° F. before melting.

This high melting point protects the building also, particularly since it acts in combination with the metal's low surface emissivity of 3% against heat flow by radiation, and so reduces the hazard of the spread of fire on the side away from the flames. Ordinarily materials, like plaster with its 93% emissivity, radiate (not conduct) considerably more heat into surrounding areas, causing them and their contents to dry up more quickly, thus making them more susceptible to rapid combustion and conflagration.

However, as an extra though perhaps unnecessary safeguard, even the fiber separators in *standard* types of multiple aluminum insulation are usually *flame-retardant*. Set a match to them and the paper merely chars.

### ASBESTOS FIBER

Where fire regulations require it, multiple accordion aluminum insulation is also available with separators made of asbestos rather than flame-retardant kraft paper.

### ASPHALT PAPER INFLAMMABLE

Ordinary insulations sometimes have a covering of asphalt-impregnated paper, which is highly inflammable.

The Associated Factory Mutual Fire Insurance Companies in their June 1948 monthly journal, *Factory Mutual Record*, page 3; and the International Association of Electrical Inspectors in its *News-Bulletin* Vol. XX, No. 3, on page 5, report this actual experience:

"The remodeling job was in general a good one. Automatic sprinklers had been retained under the roof, and additional sprinklers had been installed beneath the false ceiling, all in accordance with standard practice.

"There was, however, one vital defect. Insulating batts



had been laid loosely across the top of the joists, resting directly on the lighting fixtures. The result was that the asphalt-impregnated paper which covered the batts was in contact with the fixture, and concealed spaces were formed between the joists where fire could burn and spread out of reach of water from sprinklers.

"An electrical breakdown of a ballast unit on top of one of the fixtures resulted in overheating which ignited the paper. Flames spread along the paper, set fire to the joists of the false

ceiling, and burned in the channels between the joists. Heat progressively opened seventy-seven sprinklers under the roof overhead, but the fire was out of reach. Firemen removed sections of the ceiling and tried to extinguish the fire, using six small hose streams, but flames kept breaking out in many places. In half an hour the fire subsided and sprinklers were shut off. Flames then broke out vigorously again and it was necessary to turn on sprinklers once more. Finally the men had to chop through the roof to put out the fire."

## ELECTRICITY

Along with a *whispering campaign* about "dullness," "dust," "tarnishing," and other "bogies," misstatements have been made about aluminum foil difficulties with "electrical contacts," "static" and "lack of grounding."

### RADIO RECEPTION

One of the world's leading manufacturers of radios negotiated with Infra in the hope that the insulation could be made sufficiently shallow for lining their cabinets.

Prof. Gordon B. Wilkes of M.I.T. wrote Infra as follows on September 11, 1946:

"In my opinion, the question of static, electrical contact and grounding is of no importance. I have known of a great many houses insulated with aluminum foil and have yet to hear of any trouble from lack of electrical contact or grounding. This question was raised over ten years ago by competitors of aluminum foil insulation but no authentic case of trouble from this cause has ever been brought to my attention."

HUNDREDS OF MILLIONS of feet of aluminum insulation have been installed in structures for the past 30 years, here and abroad, with no electrical disturbances.

Leland Hubbell Lyon, architect, New Rochelle, N. Y., wrote on Jan. 15, 1947:

"I have never heard of any electrical trouble caused by foil insulation. The thought in itself seems very foolish to me because no question of electrical contact is raised when wire lath is used as a plaster base. Wire lath, as you know, is far heavier than the foil and could therefore make a better conductor. How about water, heating and gas piping which conductors often cross and parallel? Electrical conductors are

supposed to be insulated from all outside contact, otherwise trouble would arise with or without insulation.

"In my opinion the use of a foil type insulation has no effect on the electrical wiring system of a building."

### TV RECEPTION

Practical Builder, August 1951 issue, page 22, states:

"To our knowledge, aluminum foil insulation does not have any effect on the operation of a television set, regardless of whether an inside or outside aerial is used."

HUNDREDS OF MILLIONS of sq. ft. of aluminum insulation were installed during the past 17 years in buildings where television sets are in operation, and we have not yet had a single complaint. There is of course the obvious fact that all buildings have doors and windows. But in the following *extreme* case, even this situation did not prevail.

In Washington, D. C., in the D. C. National Guard Armory, 19th and E. Capitol Sts., S.E., there was a Builders' Home Show open to the public and also attended by many of the architects, engineers, builders and government officials of Washington, D. C. and environs.

The Armory, it so happens, is practically devoid of windows. The entire ceiling, and almost the entire wall, is covered with a *metallic* acoustical insulation.

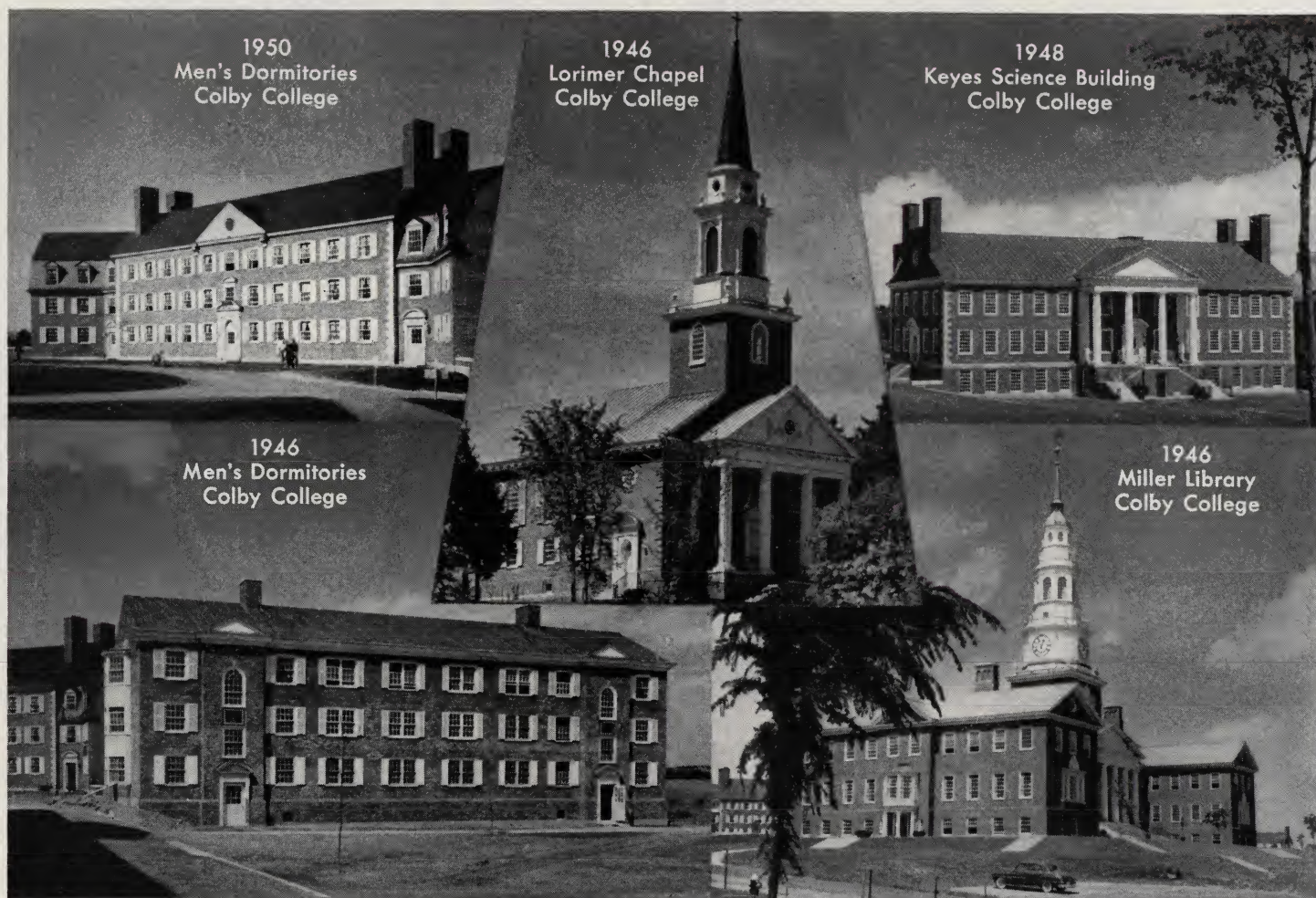
Among the exhibits were about a dozen booths exhibiting and *demonstrating* television sets. All performed well, visually and audibly, all day and every day, for the full week.

Thousands of people attended this Exhibit and saw and heard the television sets, with built-in aerials in successful operation.





# SOME TYPICAL INFRA PROJECTS



Colby College, Waterville, Maine. Jens F. Larson, architect; Hegeman-Harris Co., builders-engineers

| PROJECT                                          | BUILDER, ARCHITECT, etc.                          |
|--------------------------------------------------|---------------------------------------------------|
| ALA., A. & P. Supermarket, Fairfield.....        | C. J. Donald, Bldr.                               |
| " 26 Residences, Fairfield.....                  | Forest Hills Corp., Bldrs.                        |
| " Housing Project, Homewood.....                 | V. P. Russell Constr. Co., Bldrs.                 |
| " Architect's Res., Mt. Brook.....               | Fred Renneker, Arch.                              |
| " Architect's Res., Mt. Brook.....               | Carl Sidorfsky, Arch.                             |
| " Vaughn Weil Res., Mt. Brook.....               | Magic City Land & Dev. Co.                        |
| " Crestline Heights School, Mt. Brook            |                                                   |
|                                                  | Van Kueren, Dairs & Co., Arch.                    |
| " Spot Weld Steel Type Res., Gadsen.....         | Maben & Son, Bldrs.                               |
| " 5 Residences, Birmingham.....                  | L. D. Stackhouse, Bldr.                           |
| " Builder's Res., Birmingham.....                | J. B. Bruce, Bldr.                                |
| " Builder's Res., Birmingham.....                | Smith-Way, Inc., Bldrs.                           |
| " Jaffee Res., Birmingham.....                   | W. S. Cleage, Bldr.                               |
| " R. A. Dairs Res., Birmingham.....              | B. G. Brasker, Bldr.                              |
| " Motel, Centreville.....                        | F. H. Davis                                       |
| " Residence, Dora.....                           | J. C. Golden                                      |
| " M. C. Rumley Res., Tuscaloosa.....             | J. P. Lawrence, Bldr.                             |
| " W. B. Hardegree Res., Talladega                |                                                   |
|                                                  | Van Kueren, Dairs & Co., Arch.                    |
| CALIF., Glendora Roosevelt School, Glendora      |                                                   |
|                                                  | W. C. Harrison, Arch., Altman Constr. Co., Bldr., |
| " Palos Verdes Track, 200 homes.....             | J. C. Lindsey & Assoc., Arch.                     |
| " Federal Housing, 30 bldgs., Downey.....        | J. C. Lindsey & Assoc., "                         |
| " Brawley Schools, Brawley.....                  | A. R. Walker, Arch.                               |
| " Coachella School, Los Angeles.....             | J. B. Construction Co.                            |
| " G. H. Walker Res., Los Angeles.....            | N. Y. Ice Machine Corp.                           |
| " Crown-Zellerbach Paper Co., Los Angeles.....   | R. W. Downer Co.                                  |
| " Silverlake Community Church, Los Angeles       |                                                   |
|                                                  | H. L. Pierce, Arch.                               |
| " Grenner Res., Los Angeles.....                 | Eisen & Hart, Arch.                               |
| " St. Andrews Presbyterian Church, Redondo Beach |                                                   |
|                                                  | Pierce & Schmidt, Arch.                           |
| " M. H. Welch Res., Laguna.....                  | Paul Lazzlo, Arch.                                |
| " Southern Calif. Edison Co., Alhambra.....      | Forrest Lundstrom Co.                             |

| PROJECT                                                   | BUILDER, ARCHITECT, etc.  |
|-----------------------------------------------------------|---------------------------|
| CALIF., Architect's Res., Pomona.....                     | B. H. Anderson, Arch.     |
| " Ontario Jewish Center, Pomona.....                      | B. H. Anderson, Arch.     |
| " Rayon & Wool Factory, Pomona.....                       | Hess, Goldsmith Co.       |
| " Contractor's Bldg., Pomona.....                         | George Streit             |
| " Pomona Residence.....                                   | Ferry Heating Appliance   |
| " Les White Res., L. A. County.....                       | Herman C. Light, Arch.    |
| " C. W. Robinson Res., Chino.....                         | B. H. Anderson, Arch.     |
| " Corvallis High School, Studio City                      |                           |
| " Encino Blvd. Project, Van Nuys.....                     | Glenn Lundberg            |
| " San Fernando Valley Federal Savings Bldg., Van Nuys     |                           |
| " St. Patrick's Parish, N. Hollywood.....                 | J. A. McNeil Co.          |
| " John T. Bourke Res., Republic Films Corp., Sherman Oaks |                           |
| " Corbin St. Res., Torzana.....                           | York Construction Co.     |
| " Store Bldg., Victory Blvd., Burbank.....                | Ross Construction Co.     |
| " Dr. Wm. Stephenson Res., Pasadena.....                  | Graham Lotta, Arch.       |
| " Pasadena Residence.....                                 | Construction Assembly Co. |
| " Pasadena Residence.....                                 | Wheeler Construction Co.  |
| " Pasadena Residence.....                                 | O. K. Earl                |
| " Pasadena Residence.....                                 | Strong Bros.              |
| " Pasadena Residence.....                                 | Earl Hugins               |
| " Office Building, Claremont.....                         | Stover Bros.              |
| " Dr. Staub Res., Claremont.....                          | Hugh Walker, Arch.        |
| " Dr. Johnson Medical Bldg., Riverside.....               | Allied Engineers, Arch.   |
| " Via Soleno, Palos Verdes Estates.....                   | G. W. Kalstrom            |
| " Redwood Ave. Project, Lancaster.....                    | E. M. Fisher              |
| " Beverly Grove Drive, Beverly Hills.....                 | Malone & Son, Inc.        |
| " Moore Street Project, La Crescenta.....                 | Fred Walsh                |
| " Architect's Res., Palo Alto.....                        | Morgan Stedman, Arch.     |
| " Shadow Mt. School, Desert Palms.....                    | Bowen-Rule-Bowen, Arch.   |
| " Veteran's Memorial Hall, Colfax.....                    | Geo. Sellon, Arch.        |
| " Manteca Health Center, Manteca.....                     | Clowsley & Whipple, Arch. |
| " Frank MacBride Res., Sacramento.....                    | H. Goodpastor, Arch.      |
| " A. W. Burroughs Apts., Sacramento.....                  | Chas. Henson, Bldr.       |
| " J. Harms Res., Sacramento.....                          | H. Goodpastor, Arch.      |



# SOME TYPICAL INFRA PROJECTS

AMERICAN INSTITUTE OF ARCHITECTS DISTINGUISHED AWARD, June 1949, to Richard J. Neutra, *architect*.  
Desert House. Edgar Kaufmann res., Palm Springs, Calif.

ALASKA NATIVE SERVICE. Numerous continuing orders from United States Govt. over a period of years.

AL KHOBAR, Saudi, Arabia. Arabian American Oil Co.

ARCHITECTURAL PRODUCTS, Model Home, Arcadia, Calif., Dec. 1950. Harry E. Shoemaker, *architect*, Lehmer & Seymour, *builders*.

OUR LADY OF MERCY CONVENT, Auburn, Calif., 1950. Harry Devine, *architect*, Arcade Ins. & Matls. Co., *applicators*.

NORTH SACRAMENTO HOSPITAL, Calif., 1950. Erling Olauson, *architect*.

TERRY COURT STATE HOUSING PROJECT, Willimantic, Conn., 1950. A. R. Sharp, *architect*, J. S. Nasin Co., *builder*.

MOUNTAIN VIEW TERRACE STATE HOUSING PROJECT, Southington, Conn. Sherwood F. Jeter, Jr., *arch.*, Cianci Constr. Co., *bldr.*

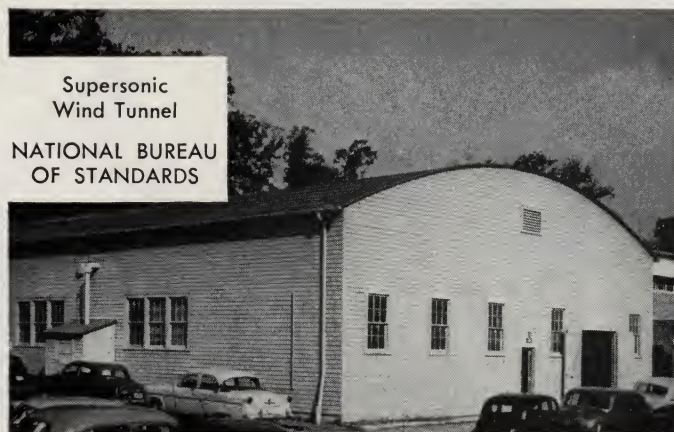
## PROJECT BUILDER, ARCHITECT, etc.

CALIF., Calif. Liquid Gas Co., Sacramento.....H. Goodpastor, Arch.  
" L-Street Market, Sacramento.....Wallace J. Alexander, Arch.  
" Musicians Hall, Sacramento.....Wallace J. Alexander, Arch.  
" Dr. Frank Lee Res., Sacramento.....John Barden, Bldr.  
" R. G. Watts Res., Redding.....H. Goodpastor, Arch.  
" Edison High School, Stockton.....Clowsley & Whipple, Arch.  
" Prefabricated Homes, Stockton.....Precision Homes Co.  
" Stonyford Elem. School, Stonyford.....Koblik & Fisher, Arch.  
" Placer Hill Elem. School, Auburn.....Gordon Stafford, Arch.  
" Carmichael Clubhouse, Carmichael.....R. Franceschi, Arch.  
" Fair Oaks Elem. School, Fair Oaks.....Gordon Stafford, Arch.  
" Seth G. Beach Res., Placerville.....Erling Olauson, Arch.  
" Weaverville Hospital, Weaverville.....H. W. Robertson, Bldr.  
" Knights of Pythias Bldg., Fresno.....Aaron Licker, Applicator  
" Glenn County Hospital, Willows.....O. A. Deichman, Arch.,  
Arcade Insulation & Materials Co., Applicators

COLO., Albion St. Apts., Denver.....Charles D. Strong, Arch.,  
Hutchinson & Carey, Bldrs., Insulation Suce. Co., Applicators  
" Ivanhoe St. Court, Denver.....Glen Huntington, Arch.,  
C. W. Johnson, Bldr.

" 24 Unit Bungalow Court, Denver.....W. B. Record, Bldrs.  
" Denver Homes, Denver.....Edw. B. Hawkins  
" Architect's Res., Denver.....Victor Hornbein, Arch.  
" Architectural Designer's Res., Denver.....W. M. Matthews, Arch.  
" Ringsby Truck Lines, Denver.....Rocky Mt. Empire Co.  
" Marvin Stone (C.P.A.) Res., Denver.....Victor Rose, Designer  
" Builder's Res., Denver.....Herman Roseland  
" Builder's Res., Denver.....W. B. Record  
" Builder's Res., Denver.....M. B. Freilinger  
" A. Carbone (Wines) Res., Denver.....Raymond H. Ervin, Arch.  
" 91 Sun-Age Homes, Denver.....J. B. Lort, Jr. & Assoc., Arch.,  
A. D. Jones Realty Co., Bldrs.

CONN., Louis E. Lee Res., New Canaan.....E. W. Howell Co.  
" 33 Residences, North Branford.....Edwards Constr. Co., Bldrs.  
" Marshall Gardens, Hartford.....Julius Berenson, Arch.  
" Popular Food Market, Hartford.....Kane & Fairchild, Arch.  
" Johnson Res., West Hartford.....Oscar Johnson, Bldr.  
" Tyrol Res., West Hartford.....Malcolm Knox, Arch.  
" Architect's Res., West Hartford.....Louis Drakos, Arch.  
" Burling Res., West Hartford.....Walter Crabtree, Jr., Arch.  
" Leblond Res., West Hartford.....A. E. Sholberg, Bldr.  
" Smith Res., West Hartford.....E. W. Canning, Arch.  
" 3 Homes, West Hartford.....Howard Menzel, Bldr.  
" 3 Homes, West Hartford.....H. B. Reynolds, Bldr.  
" Bortman Res., West Hartford.....Sol Winick, Bldr.



Washington, D. C. December, 1949  
M. Jones, engineer, National Bureau of Standards  
Lee T. Turner, builder  
(All outer walls and ceilings complete)

## PROJECT BUILDER, ARCHITECT, etc.

CONN., Peterson Res., Bloomfield.....Louis Drakos, Arch.  
" Thornton Res., Bloomfield.....The R. B. Swain Co., Bldr.  
" Andrew F. Kay Res., Wethersfield.....Kay Constr. Co., Bldr.  
" Wellsridge Inc., 10 Homes, Wethersfield.....Hollis Kincaid, Arch.  
" 25 Homes, Manchester.....Thomas De Luca, Arch.  
" 52 Homes, Fair Oaks Hills, Windsor.....Willard Wilkins, Arch.,  
Anderson Fair Oaks Constr. Co., Bldr.

" 85 Residences, Sunrise Heights Development, Newington  
S. Ivar Johnson Co., Bldr.  
" 16 Residences, Hamden.....G. Levine Constr. Co., Bldrs.  
" Claremore Apartments, Norwalk.....Morris Weinberger, Bldr.,  
Everett C. Bradley, Arch.  
" Architect's Res., Greenwich.....J. E. Wideberg, Bldr.,  
Holden, McLaughlin, Arch.

DEL., 65 Houses, Elsmere.....A. J. Vilone, Designer & Bldr.  
" 12 Houses, Bellemoor Heights.....Bellemoor Hts., Inc.  
" 10 Houses, Kaimensi Gardens, Stanton.....Carmen Silicato  
D. C., F St. S.E. Housing.....Jay-Bee Constr. Co., Bldr.,  
Geo. Santmyers, Arch.

" Atlantic & 3rd St., S.E.....Michael Sesso & Co.  
" Housing Project, S.E.....V. Innamorato  
" Shepherd Gardens III, S.E.....Schreier-Patterson, Arch.  
Fink Constr. Co., Bldr.

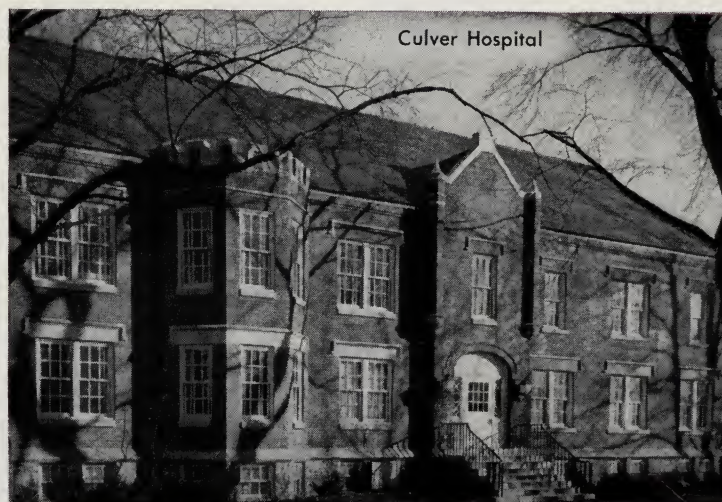
" Silver Fox Tavern.....Lee J. Turner  
FLA., Ford Factory Built Homes, Palatka.....J. W. Campbell  
" Architect's Res., Jacksonville.....Reynolds, Smith & Hills, Arch.  
" Architect's Res., Jacksonville.....Walter B. Schultz, Arch.  
" Ferndale Housing Project, Jacksonville.....A. Wurn, Bldr.  
" 30 Houses, Milmar Manor, Jacksonville.....A. Wurn, Bldr.  
" 50 Houses, Glen Laura, Jacksonville.....Coward & Gonzalez, Bldr.  
" 33 Houses, Pineview Heights, Jacksonville.....L. C. Pearce, Bldr.  
" 80 Houses, Longwood, Jacksonville.....H. S. Brownnett, Bldr.  
" 50 Houses, Jacksonville.....Hanna-Boutross, Bldr.  
" Arlington Park, Jacksonville.....Victor Homes  
" Dr. Weil's Residence, Jacksonville.....Willis Stephens, Arch.  
" Piners Supermarket, Jacksonville.....H. H. Peck, Bldr.  
" Carl P. Swisher Res., Jacksonville.....R. Seymour, Arch.  
" Waldrop Res., Jacksonville.....Reynolds-Smith & Hill, Arch.  
" Lovetts Supermarket, Jacksonville.....A. Hopkins, Arch.



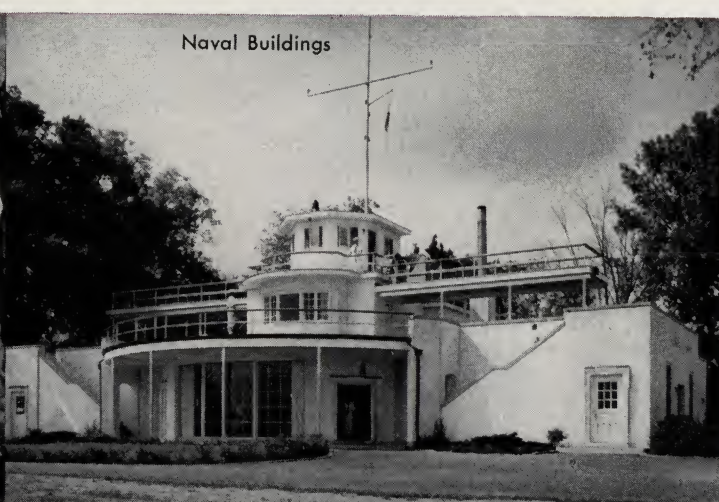
Frank Sinatra, residence, Palm Springs, Calif.  
Harry Williams & Sons, architects.



# SOME TYPICAL INFRA PROJECTS



Culver Hospital



Naval Buildings

CULVER MILITARY ACADEMY, CULVER, INDIANA. June 1948

Jens F. Larson, architect

Barnes Constr. Co., builders

PURDUE UNIVERSITY, Lafayette, Indiana. Students Housing Project.

COLD STORAGE COOLER, Moline, Illinois. Consumers Sales Agency.

CAUBLE'S HATCHERY, Pekin, Indiana. Kentucky Insulation & Supply Corp., applicator.

JAMES J. POLLARD, Architect's Res., Atlanta, Ga., 1950. Pollard & Altobellis, architects & engineers.

WATHENA APPLE GROWERS ASSOCIATION, Wathena, Kansas. (Cold Storage)

| PROJECT                                             | BUILDER, ARCHITECT, etc.                    |
|-----------------------------------------------------|---------------------------------------------|
| FLA., W. J. Cowart Res., Jacksonville.....          | W. J. Cowart, Bldr.                         |
| " Architect's Res., Jacksonville.....               | R. Seymour, Arch.                           |
| " John Blow Res., Jacksonville.....                 | Marsh & Saxelbye, Arch.                     |
| " Architect's Res., Jacksonville.....               | R. Darby, Arch.                             |
| " S.W. Florida Tuberculosis Sanatorium, Tampa       | C. F. Kuhn, Arch., Thomas H. Radford, Bldr. |
| " Motel, Daytona Beach.....                         | Hendricks & Cobbs                           |
| " C. J. P. Brown's Apt., Daytona Beach.....         | D. A. Leete, Arch.                          |
| " Coca Cola Bldg., Daytona Beach.....               | Reynolds-Smith-Hill, Arch.                  |
| " Architect's Res., Daytona Beach.....              | F. Walton, Arch.                            |
| " Roots Res., Ormond Beach.....                     | McCracken & Berry                           |
| " Maurice Motor Court, North Miami.....             | Robert Fitch Smith                          |
| " Shores Club Court Motel, Miami Shores             | Pamorrow Turner, Arch.                      |
| " Thiel Chevrolet Bldg., Miami.....                 | Robert Fitch Smith, Arch.                   |
| " Brynell Apts., Miami Beach.....                   | Harry O. Schwabke, Arch.                    |
| " Goldcoast Apts., Miami Beach.....                 | August Swarz, Arch.                         |
| " Augusta Apts., Miami.....                         | James H. Chance, Arch.                      |
| " Sandy Shores Hotel, Miami Beach.....              | Norman Giller, Arch.                        |
| " Hampshire House, Miami Beach.....                 | Leonard Glasser, Arch.                      |
| " Sunny Shores Hotel, Miami Beach.....              | T. H. Henderson, Arch.                      |
| " Florida Dairies Milk Plant, Miami.....            | W. T. Eefsting, Arch.                       |
| " Alexander Clinic, Miami.....                      | Robert Law Weed, Arch.                      |
| " Florida State University Dormitories, Tallahassee | Reynolds-Smith & Hill, Arch.                |
| GA., Prefabricated Homes, Marietta.....             | U. S. Homes, Inc.                           |
| " Prefabricated Homes, Ellaville.....               | Georgia Con. Contr. Co.                     |
| " Howard M. Patterson Res., Decatur.....            | Finch & Barnes, Arch.                       |
| " American Type Foundry, Atlanta.....               | M. Fowler                                   |
| " E. Atlanta Sub-Division, Atlanta.....             | J. D. Venable                               |
| " Clairmount Road Homes, Atlanta.....               | DeKalb Builders                             |
| " Beverly Rd., N.W., Atlanta.....                   | Allen Wesley                                |
| " Techwood Dr., N.W., Atlanta.....                  | Norris Construction Co.                     |
| " Morris Abram Res., Atlanta.....                   | Alexander & Rothchild, Arch.                |
| " J. T. Weems Res., Atlanta.....                    | Knox A. Griffin, Arch.                      |
| " N. A. Weitz Res., Atlanta.....                    | Geo. Post Foote, Arch.                      |
| " J. H. Boston Res., Atlanta.....                   | Montgomery Turner, Arch.                    |
| " Russell Gill Res., Atlanta.....                   | L. W. Vanover, Arch.                        |
| " R. S. Brady Res., Atlanta.....                    | Lewis & Bachler, Designers & Bldrs.         |
| " DeBraw Brothers Res., Atlanta.....                | R. B. Powell, Designer & Bldr.              |
| " A. Q. Smith Apts., Atlanta.....                   | Griffin Constr. Co.                         |
| " W. W. Lovell Res., Atlanta.....                   | Henry D. Norris, Arch.                      |
| " Luke W. Brown Res., Atlanta.....                  | Mack Scarborough, Bldr.                     |
| " Jerger Res., Thomasville.....                     | R. Fetner, Arch.                            |
| " Georgian Autotel.....                             | McKenny & Fitts                             |
| ILL., Architect's Res., Chicago.....                | J. V. McPherson, Arch.                      |

| PROJECT                                                        | BUILDER, ARCHITECT, etc.                            |
|----------------------------------------------------------------|-----------------------------------------------------|
| ILL., Apple House & Cold Storage, Rock Island.....             | M. Smith                                            |
| " Selhost Amusement Hall, Rock Island.....                     | C. H. Langman & Son                                 |
| " Residence, Rock Island.....                                  | Joe Bennett                                         |
| " 12 Residences, Rock Island.....                              | Mason & Ellis                                       |
| " Jul's Danish Farm, Moline.....                               | M. R. Beckstrom, Arch., A. H. Arp, Bldr.            |
| " 8 Residences, Moline & Rock Island.....                      | Ericson Const. Co.                                  |
| " 5 Residences, Moline.....                                    | C. E. Peterson's Sons                               |
| " Moline Residence, Moline.....                                | Ed Cabor                                            |
| " 4 Residences, Moline.....                                    | Chester Anderson                                    |
| " 2 Residences, East Moline.....                               | B. A. Shearer                                       |
| " 2 Residences, Silvis.....                                    | B. A. Shearer                                       |
| " Residences, Brookfield.....                                  | Fisher & Willms, Bldrs.                             |
| " Residences, Skokie.....                                      | Community Builders, Inc.                            |
| " Residences, Chicago.....                                     | Celig Builders                                      |
| " Residences, Chicago.....                                     | Oak Park Construction Co.                           |
| " Residences, Chicago.....                                     | W. R. Kramer & Co., Bldrs.                          |
| " Residences, Chicago.....                                     | Smith and Hall, Inc.                                |
| " Residences, Chicago.....                                     | City Wide Builders                                  |
| " Residences, Chicago.....                                     | G. Petrone, Bldrs.                                  |
| " Residences, Chicago.....                                     | Community Developers, Inc.                          |
| " Res., Chicago.....                                           | George Keck and William Keck, Arch.                 |
| " Residences, St. Charles.....                                 | C. A. Anderson Co., Bldrs.                          |
| " Residences, Calumet City, Hyde Park Roofing & Insulating Co. |                                                     |
| " Residences, Oak Park.....                                    | E. L. Austin Co., Bldrs.                            |
| IND., Carnegie-Illinois Steel Co., Gary.....                   | J. W. Galbreath & Co.                               |
| " 200 House Project, Indianapolis.....                         | Monroe Corp.                                        |
| " Prefabricated Homes, Richmond.....                           | Richmond Builders Inc.                              |
| " Mishawaka Supply Co., Mishawaka.....                         | Karl Schwartz, Arch.                                |
| " Higbie Res., Jeffersonville.....                             | Ky. Insul. & Supply Corp.                           |
| " Fire Station No. 5, South Bend.....                          | Vincent F. Fagan, Arch.                             |
| " 60 House Project, South Bend.....                            | Russell Stapp Co.                                   |
| " Green Township School, South Bend.....                       | Thomas L. Hickey, Contr.                            |
| " Fire Station, South Bend.....                                | Schwartz & West, Arch.                              |
|                                                                | Vincent F. Fagan, Arch., H. G. Cristman Co., Contr. |
| IOWA, Town-House Restaurant, Sioux City.....                   | Modern-Age Co.                                      |
| " Refrigeration Engineering Co., Sioux City.....               | Soren Hansen                                        |
| " Salsness, Chrysler-Plymouth, Sioux City.....                 | Modern-Age Co.                                      |
| " 3 Houses, Sioux City.....                                    | Hedeen & Cooper                                     |
| " Grandy-Pratt Cotton Co., 6 Bldgs., Sioux City.....           | Max Wilsey                                          |
| " Garritt Grasma, R-C-C-Motel, Sioux City.....                 | Modern-Age Co.                                      |
| " Residences, Dubuque.....                                     | Render Block Co.                                    |
| KANSAS, McSorley Res., Kansas City                             |                                                     |
| " H. W. Everhart Res., Kansas City                             |                                                     |



# SOME TYPICAL INFRA PROJECTS



MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, Mass.

Students' Housing

250,000 sq. ft. of Infra in 250 cartons were loaded on 1 truck in TWO HOURS and delivered on the job several hours later. Ordinary insulation would have required loading and carting 6,250 bulky boxes on 25 trucks to 12 railroad cars, reloading 25 trucks, unloading at the project; and employing a large crew for weeks just to distribute it.

ELECTRICALLY HEATED Miller Residence, Sumner, Md., 1950. Miller Development Co., *builder*.

GILCHRIST CO. STORE BLDG., Framingham, Mass. August 1948. Barnes & Champrey, *architects*.  
George B. H. Macomber Co., *builders*. STEEL TRUSSES. RADIANT HEATING.

PENNSYLVANIA POOL CAR STORAGE, Detroit, Mich. Albert Kahn & Assoc., *arch.*, Cunningham-Limp, *bldrs*.

| PROJECT                                   | BUILDER, ARCHITECT, etc.                                  |
|-------------------------------------------|-----------------------------------------------------------|
| KY., Norrenbrook Electric Co., Louisville | <i>Applicator, Kentucky Insulation &amp; Supply Corp.</i> |
| " Walker Cunningham Res., Louisville      | <i>Applicator, Kentucky Insulation &amp; Supply Corp.</i> |
| " Eddie Woolridge Camp, Kentucky Lake     | " " " "                                                   |
| " Galloway Motor Co., Bowling Green       | " " " "                                                   |
| LA., Levy Warehouse Co., Baton Rouge      | <i>Jack Wilson, Arch.</i>                                 |
| " International Trade Mart, New Orleans   | <i>Weil &amp; Moses, Engr.</i>                            |
| MAINE, Bowdoin College, Brunswick         | <i>Dept. of Physics</i>                                   |
| MASS., Westover Field, Chicopee Falls     | <i>Ley Construction Co.</i>                               |
| " Dennison Mfg. Co., Framingham           | <i>Coolidge &amp; Carlson, Arch.</i>                      |
|                                           | <i>George W. McCreery Co., Contractors</i>                |
| MD., Stores, Suitland                     | <i>W. E. Dickinson, Arch.</i>                             |
|                                           | <i>F. DiZebba &amp; Sons, Bldrs.</i>                      |
| " Food Plant, Brentwood                   | <i>Eisen Constr. Co.</i>                                  |
| " Bottling Plant, Owing Mills             | <i>Park &amp; Tilford Distillers, Inc.</i>                |
| " Pinkney Courts Apts., Baltimore         | <i>Marsam Constr. Co.</i>                                 |
| " School No. 154, Baltimore               | <i>Department of Maintenance</i>                          |
| " Brand Auto Showroom, Baltimore          | <i>G. Bonnett, Arch.</i>                                  |
| " Store, Baltimore                        | <i>Wm. J. Armiger, Bldr.</i>                              |
| " Church, Baltimore                       | <i>M. B. Duerling, Bldr.</i>                              |
| " Builder's Res., Baltimore               | <i>K. R. Wilde, Bldr.</i>                                 |
| " Halloway Res., Baltimore                | <i>Palmer, Fisher, Williams-Nes, Bldr.</i>                |
| " 9 Residences, Baltimore                 | <i>J. Forsythe, Arch.</i>                                 |
| " 9 Residences, Baltimore                 | <i>Woodland Contractors Inc., Bldr.</i>                   |
| " 8 Residences, Baltimore                 | <i>Builders Inc., Bldr.</i>                               |
| " 6 Residences, Baltimore                 | <i>Harry Samson, Bldr.</i>                                |

| PROJECT                                  | BUILDER, ARCHITECT, etc.                                     |
|------------------------------------------|--------------------------------------------------------------|
| MD., Brand Auto Showroom, Baltimore      | <i>G. Bonnett, Arch.</i>                                     |
| " 3 Residences, Baltimore                | <i>Westwood Hills, Bldr.</i>                                 |
| " 2 Residences, Baltimore                | <i>Forward Inc., Bldr.</i>                                   |
| " 2 Residences, Baltimore                | <i>David Leonard, Bldr.</i>                                  |
| " Residence, Baltimore                   | <i>Integrity Corp., Bldr.</i>                                |
| " 18 Residences, Essex                   | <i>Bolton Co., Bldr.</i>                                     |
| " 3 Residences, Towson                   | <i>A. J. Klunk, Bldr.</i>                                    |
| MICH., Veremus Apts., Saginaw            | <i>Spence Bros., Contr.</i>                                  |
| " Westenedge Hill Apts., Kalamazoo       | <i>William A. Stone, Arch.</i>                               |
|                                          | <i>A. T. Newbold Constr. Co., Bldrs., Altman Constr. Co.</i> |
| " West Acres, Pontiac                    | <i>Harlan Smith, Arch.</i>                                   |
| " Clio School, Flint                     | <i>S. A. Nurmi, Arch.; A. Johnson, Bldr.</i>                 |
| " Dr. McNeill's Res., Pontiac            | <i>Wallace Frost, Arch.</i>                                  |
| " Michigan State College, Traverse       | <i>Andres L. Olson</i>                                       |
| " Pre-Cut Homes, Albion                  | <i>E. E. Stokoe Co.</i>                                      |
| " Grandview Elementary School, Grandview | <i>Walter H. Rothe, Arch., Edmund P. Erwen, Bldr.</i>        |
| " Animal Shelter, Ann Arbor              | <i>Giffels, Valet &amp; Rossetti, Arch.</i>                  |
| " L. Rossetti (Arch.) Res., Lake Orion   | <i>Giffels, Valet &amp; Rossetti</i>                         |
| " E. A. Skae Res., Grosse Pointe         | <i>Francis Palms, Arch.</i>                                  |
| " Mich. Unempl. Comp. Bldg., Detroit     | <i>Merle Hogan, Arch.</i>                                    |
| " Harold E. Rapp Res., Detroit           | <i>Clarence Durbin, Arch.</i>                                |
| " Detroit Bible Institute                | <i>Lee N. Butler, Arch.</i>                                  |
| " Project at Monroe                      | <i>W. G. Snell &amp; Co.</i>                                 |
| " A. C. Emmerling Res. (Arch.)           | <i>Emmerling, Spellicy &amp; Hartman</i>                     |
| " J. Weidman Res., Plymouth              | <i>B. H. Baker, Arch.</i>                                    |
| " G. C. Brown Res., Birmingham           | <i>John G. Spittal, Bldr.</i>                                |
| " Architect's Res., Flint                | <i>S. A. Nurmi, Arch.</i>                                    |



# SOME TYPICAL INFRA PROJECTS

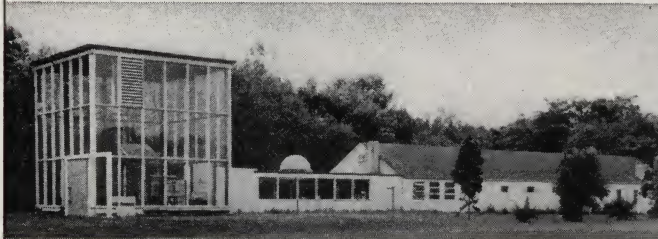
## PRINCETON, NEW JERSEY



1948 — FERRIS THOMPSON FACULTY HOUSING  
HOLDEN & McLAUGHLIN & ASSOC., Architects; IRONS & REYNOLDS, INC., Builders



1948 — INSTITUTE FOR ADVANCED STUDY  
JENS F. LARSON, Architect; GEORGE A. FULLER CO., Builder



1955 — ARCHITECTURAL LABORATORY  
DESIGNED BY THE PRINCETON SCHOOL OF ARCHITECTURE  
MATTHEWS CONSTR. CO. and BOWERS & SONS, INC., Builders



1947 — STANWORTH HOUSING, 152 UNITS  
HOLDEN & McLAUGHLIN & ASSOC., Architects; WM. L. CROW CONSTR. CO., Builders  
NEW YORK LIFE INSURANCE CO., Owner

| PROJECT                                                      | BUILDER, ARCHITECT, etc.     |
|--------------------------------------------------------------|------------------------------|
| MINN., Prefabricators, Waterville.....                       | Fanning Supply Co.           |
| " Utica Mining Co., Hibbing.....                             | Arrowhead Steel, Inc.        |
| " M. A. Hanna Mining Co., Hibbing.....                       | Arrowhead Steel, Inc.        |
| " Far West Homes, St. Cloud.....                             | Granite City Constr. Co.     |
| " DeZurik Shower Co., Sartell.....                           | Steel Structures, Inc.       |
| " Bovey Res., Fernadale.....                                 | McEnery & Kraft              |
| " Clare Long Res., Lake Minnetonka.....                      | McEnery & Kraft              |
| " E. J. Hoy Homes, Richfield.....                            | Hoy Constr. Co.              |
| " North Union Ave. Homes, Fergus Falls.....                  | Noyes Constr. Co.            |
| " R. F. Gray Res., Austin.....                               | Ziemer Constr. Co.           |
| " Park Manor Apts., Minneapolis.....                         | Sauers Constr. Co.           |
| " Victor Anderson Res., St. Cloud.....                       | Home Builders, Inc.          |
| " Community Hospital, Westbrook.....                         | Frost & Lofstrom, Arch.      |
| " Cleveland Cliffs Mining Co., Taconite.....                 | Arrowhead Steel, Inc.        |
| " S. A. Stock Res., Owatonna.....                            | S. A. Stock, Bldr.           |
| " Northern States Power Co. Station, Nichols.....            | Butler Mfg. Co.              |
| " Lutheran Church, Mankato.....                              | Wick & Stansfield, Arch.     |
| " Greyhound Lines, Inc., Office Building, Minneapolis        | Leck Co., General Contractor |
| MISSOURI, Feld Chevrolet, St. Louis.....                     | I. E. Millstone Constr. Co.  |
| " Student Activities Bldg., Washington University, St. Louis | I. E. Millstone Constr. Co.  |
| " Eilers Res., St. Louis.....                                | Joe Mueller Realty           |
| " Len A. Maune Co. Office & Warehouse, St. Louis             | Woermann Constr. Co.         |
| " Dean Residence, St. Louis County.....                      | M. L. Pollard, Applicator    |
| " Carlson Res., St. Louis County.....                        | M. L. Pollard, Applicator    |
| " Brand & Puritz, Garment Factory, Kansas City               |                              |
| " Minute Man Car Wash, Kansas City                           |                              |
| " Residence, Clayton.....                                    | E. Wade Hankins              |
| " Branding Iron Restaurant, Clayton.....                     | M. L. Pollard, Applicator    |
| " Earickson Res., Clayton.....                               | M. L. Pollard, Applicator    |
| " Forrest Keeling Nursery, Elsberry.....                     | M. L. Pollard, Applicator    |
| " Greenleaf Res., Kirkwood.....                              | M. L. Pollard, Applicator    |
| " Residence, Kirkwood.....                                   | Ferd Bopp Construction Co.   |
| NEVADA, Boulder Canyon, Boulder City, Bureau of Reclamation  | Aaron Licker, Applicator     |

| PROJECT                                    | BUILDER, ARCHITECT, etc.                            |
|--------------------------------------------|-----------------------------------------------------|
| N. J., John Zaktansky, Res., Metuchen..... | Murray Leibowitz, Arch.                             |
| " Publix Drug Store, Woodbridge.....       | Murray Leibowitz, Arch.                             |
| " Architect's Res., Perth Amboy.....       | Murray Leibowitz, Arch.                             |
| " Dover Gardens, Dover.....                | Gustin Iser, Arch.                                  |
| " 120 Homes, Dover.....                    | Bonded Contr. Co., Bldrs.                           |
| " Research Bldrs., No. Bergen.....         | Leon H. Katz                                        |
| " Warren Portahome Co., Mays Landing.....  | J. T. Warren, Jr.                                   |
| " Rosemont Constr. Co., Union.....         | Portnoff Bros.                                      |
| " F. U. Realty Co., Union.....             | Frank Umanetz                                       |
| " Ridgeview Terrace Garden Apts.....       | Hunt Engr. Co., Bldr.-Arch.                         |
| " Factory, Millburn.....                   | Culligan Zeolite Co.                                |
| " Architect's Res., Haddonfield.....       | Edward & Green, Arch.                               |
| " Residences, Haddonfield.....             | W. W. Ruggles, Bldr.                                |
| " Residence, Moorestown.....               | Albert Perla, Bldr.                                 |
| " Starlite Motel, Maple Shade.....         | John Bond, Bldr.                                    |
| " 30 Homes, Palisades Park.....            | Baresi & Son, Bldr.                                 |
| " Architect's Res., Palisades Park.....    | James Virgona, Arch.                                |
| " Plateau Gardens, Palisades Park.....     | L. Feinen, Arch.,<br>Ridgelee, Bldrs.               |
| " Architect's Res., Englewood.....         | Lawrence Licht, Arch.<br>Beggs Bros., Bldrs.        |
| " Franklin Furniture, Englewood.....       | L. Moon, Arch.,                                     |
| " Res., Englewood.....                     | L. Moon, Arch., A. Warga, Bldr.                     |
| " Res., Englewood.....                     | L. Fischer, Arch., Lewis & Wideltz, Bldrs.          |
| " 10 Factories, Englewood.....             | Beggs Bros., Bldrs.                                 |
| " Solomon Stores, Englewood.....           | Fred Harsen, Arch.,<br>Beskin-Freeman, Inc., Bldrs. |
| " Post Office, W. Englewood                |                                                     |
| " Arch. Res., Englewood Cliffs.....        | M. Geo. Vuinovich, Arch.                            |
| " St. Hyacinth Rectory, Paterson.....      | Thomas Constr. Co., Bldr.                           |
| " Teachers College, Paterson.....          | L. Licht, Arch.,<br>Thomas Constr. Co., Bldrs.      |
| " Speed Parts, Inc., E. Paterson.....      | Colin Constr. Co., Bldr.                            |
| " Herman's Flr. Covering, E. Paterson..... | J. Savieranna, Bldr.                                |
| " Grand Union Super Market, Paterson.....  | P. Holley, Arch.,<br>Thomas Constr. Co., Bldr.      |



# SOME TYPICAL INFRA PROJECTS

RUTGERS UNIVERSITY, N. J., 1950. Demarest Hall. York & Sawyer, *archs.*,  
Fred L. Moesel Assocs., *eng.*, A. Christensen & Son, *bldr.*

RUTGERS UNIVERSITY, N. J., York & Sawyer, *Architects.*  
Christensen & Son, *Builders.* Student Center Pharmacy Building, N. J. College for Women.

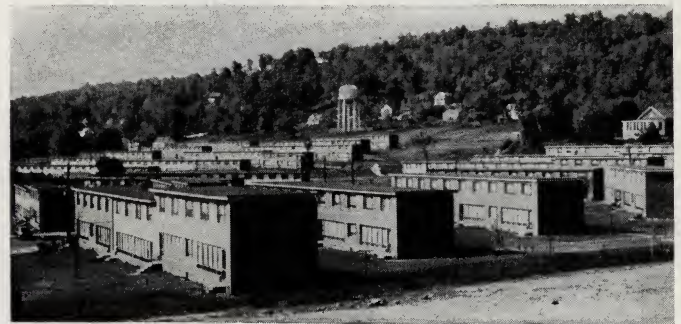
GRAND UNION MAIN OFFICES, E. Paterson, New Jersey, 1952. Kelly & Gruzen, *Architects.*  
100,000 sq. ft. of Infra. Ferber Co., *Builders.*

SAFeway SUPER MARKET, Clifton, New Jersey, 1955. Turner Const. Co., *Builders.*

TRENTON APARTMENTS, Elizabeth, New Jersey, 1952. Erwin Gerber, *Architect.* G & L Corp., *Builders.*

| PROJECT                                            | BUILDER, ARCHITECT, etc.                                              |
|----------------------------------------------------|-----------------------------------------------------------------------|
| N. J., Shopping Ctr., River Edge.....              | B. Nelson & Son, <i>Bldr.</i>                                         |
| " Sacred Heart Rectory, Rockaway.....              | M. Geo. Vuinovich, <i>Arch.</i> ,<br>Callahan Bros., <i>Bldrs.</i>    |
| " Res., Cresskill.....                             | Sidney Schenker, <i>Arch.</i> ,<br>Palomba & Levine, <i>Bldrs.</i>    |
| " Architect's Res., Cresskill .....                | Lawrence Moon, <i>Arch.</i>                                           |
| " Res., Rutherford.....                            | James Centanni, <i>Arch.</i> , Dan Melfi, <i>Bldrs.</i>               |
| " Architect's Res., W. Orange.....                 | Leo Fischer, <i>Arch.</i>                                             |
| " Architect's Res., W. Orange.....                 | Joseph Scrocco, <i>Arch.</i>                                          |
| " Grand Union & Shopping Ctr., W. Orange.....      | K. Higgins, <i>Arch.</i> ,<br>F. H. Mulcahy Co., <i>Bldr.</i>         |
| " Architect's Res., S. Orange.....                 | Nathan Siegler, <i>Arch.</i>                                          |
| " Blvd. North Apts., Hasbrouck Heights.....        | S. Hekemian Co., <i>Bldrs.</i>                                        |
| " Res., Hasbrouck Heights.....                     | N. Dinallo, <i>Bldrs.</i>                                             |
| " Res., Caldwell.....                              | S. Bryan Baylinson, <i>Arch.</i>                                      |
| " Res., Saddle River Boro.....                     | E. Petterson, <i>Arch.</i> , M. & E. Co., <i>Bldrs.</i>               |
| " Arch. Res., Saddle River Boro.....               | Eleanor Petterson, <i>Arch.</i>                                       |
| " El. School, Mahwah.....                          | Jay C. Van Nuys, <i>Arch.</i> ,<br>Thomas-Aiken Co., <i>Bldrs.</i>    |
| " El. School, Mahwah.....                          | Jay C. Van Nuys, <i>Arch.</i> ,<br>Lehmann Constr. Co., <i>Bldrs.</i> |
| " 2 Schools, New Milford.....                      | A. Rigolo, <i>Arch.</i> , Glenwal Co., <i>Bldrs.</i>                  |
| " 1st National Bank, Totowa.....                   | F. Vreeland, <i>Arch.</i> ,<br>Thomas Constr. Co., <i>Bldrs.</i>      |
| " "2 Guys from Harrison," Chain Stores, Totowa     | McKay Corp., <i>Bldrs.</i>                                            |
| " "2 Guys from Harrison," Chain Stores, Plainfield | "                                                                     |
| " Epiphany Church, Cliffside Park.....             | M. Geo. Vuinovich, <i>Arch.</i> ,<br>Romagnino Constr., <i>Bldr.</i>  |
| " St. Joseph's Church, Demarest.....               | M. Geo. Vuinovich, <i>Arch.</i> ,<br>Thomas Constr. Co., <i>Bldr.</i> |
| " Robert Hall Store, West N. Y.....                | Chuckrow & Wyckoff, <i>Bldrs.</i>                                     |
| " Robert Hall Store, Bloomfield                    |                                                                       |
| " Res., Preakness.....                             | S. E. Greydanus, <i>Arch.</i> , Geo. Peterson, <i>Bldr.</i>           |
| " Safeway Super Market, Hackensack.....            | Turner Constr. Co., <i>Bldr.</i>                                      |
| " 4 Factories, Hackensack.....                     | John Kindergan, <i>Bldrs.</i>                                         |
| " Safeway Super Market, Long Branch.....           | Turner Constr. Co.                                                    |
| " Library, Mountain Lakes.....                     | H. Vernon Lee, <i>Arch.</i>                                           |
| " A & P Super Market, Hoboken.....                 | Tamburelli Constr., <i>Bldr.</i>                                      |
| " Eisen Bros. Furniture, Hoboken.....              | Taylor Constr. Co., <i>Bldr.</i>                                      |
| " General Foods, Hoboken.....                      | Lorio Const. Co., <i>Bldrs.</i>                                       |
| " Galsworthy, Inc., Newark.....                    | Max Drill, Inc., <i>Bldrs.</i>                                        |
| " Tenaflly Printing Co., Tenaflly                  |                                                                       |
| " A & P Super Market, Tenaflly.....                | Beggs Bros., <i>Bldrs.</i>                                            |
| " Wonder Market, Glen Rock.....                    | Peter Holley, <i>Arch.</i> ,<br>Glenwal Co., <i>Bldr.</i>             |
| " Architect's Res., Lakewood.....                  | Rolland Holbrook, <i>Arch.</i>                                        |
| " 625 Homes, Sayreville                            |                                                                       |
| " Super Market, Teaneck.....                       | Robt. Lee Co., <i>Bldr.</i>                                           |
| " 44 Homes, Teaneck.....                           | Research Corp.                                                        |
| " Har-Di Apts., Teaneck.....                       | P. Butler, <i>Arch.</i> , D. Diaz, <i>Bldrs.</i>                      |
| " Bell Telephone Co., Teaneck.....                 | Remmus Constr. Co., <i>Bldrs.</i>                                     |
| " 29 Houses, Teaneck.....                          | Avento Constr. Co.                                                    |
| " Spotts DeSoto Co., Leonia.....                   | Paramount Homes Imp. Co., <i>Bldr.</i>                                |
| " Williams Foundry Plant, Carlstadt.....           | L. Moon, <i>Arch.</i> ,<br>Ferguson Constr. Co., <i>Bldrs.</i>        |

| PROJECT                                          | BUILDER, ARCHITECT, etc.                                               |
|--------------------------------------------------|------------------------------------------------------------------------|
| N. J. Chicken Coop, Wyckoff.....                 | Geo. Eder, <i>Bldr.</i>                                                |
| " North Am. Van Lines, Clifton.....              | P. Holley, <i>Arch.</i> ,<br>Thomas-Aiken Co., <i>Bldrs.</i>           |
| " Gardner Building, Clifton.....                 | Thomas-Aiken Co., <i>Bldrs.</i>                                        |
| " El. School, Clifton.....                       | A. Rigolo, <i>Arch.</i> , I. Degenars Co., <i>Bldrs.</i>               |
| " Library, Clifton.....                          | J. DeRose, <i>Arch.</i> , Colin Constr. Co., <i>Bldrs.</i>             |
| " Brogan Cadillac Co., Clifton.....              | P. Holley, <i>Arch.</i> ,<br>Thomas Constr. Co., <i>Bldrs.</i>         |
| " First Ref. Church, Secaucus.....               | S. J. Setti, <i>Arch.</i> ,<br>Censulla-Burke Co., <i>Bldrs.</i>       |
| " St. Elizabeth's Convent, Wyckoff.....          | Lucas Bannon, <i>Arch.</i> ,<br>Colin Constr. Co., <i>Bldr.</i>        |
| " Weinberg Chevrolet Co., Bergenfield            | Beshkin-Freeman, Inc., <i>Bldrs.</i>                                   |
| " American Stores, Lodi.....                     | L. Fischer, <i>Arch.</i> , Judal Constr. Co., " "                      |
| " Housing Project, Lodi.....                     | Kelly & Gruzon, <i>Arch.</i>                                           |
| " L. L. Constantin Co., Lodi                     |                                                                        |
| " General Woodcraft Co., North Bergen            |                                                                        |
| " Steinback Store, Red Bank.....                 | H. Boyer, <i>Arch.</i> ,<br>T. V. Leo Co., <i>Bldr.</i>                |
| " Huffman & Boyle Chain Stores, Springfield..... | L. Fellgraf, <i>Arch.</i>                                              |
| " 33 Homes, Rivervale.....                       | Eastern States Constr. Co., <i>Bldrs.</i>                              |
| " Elmora Arms, Elizabeth.....                    | E. Gerber, <i>Arch.</i> , Siwel Corp., <i>Bldrs.</i>                   |
| " Jennie Manor, Highlands.....                   | Braun & Mancuso, <i>Archs.</i> ,<br>B. J. Lucarelli Co., <i>Bldrs.</i> |
| " Swimming Pool, Jersey City.....                | Clark & Hartman, <i>Archs.</i> ,<br>Vincent Sica, <i>Bldr.</i>         |



Colonial Site Housing, Paterson, New Jersey  
Kelly & Gruzen, *arch.*; Terminal Constr. Co., *bldrs.*  
150,000 sq. ft. of Infra Insulation

|                                     |                                                               |
|-------------------------------------|---------------------------------------------------------------|
| N. J., Post Office, Keyport.....    | Robert Frank, <i>Bldr.</i>                                    |
| " Church, Wanamassa.....            | S. E. Greydanus, <i>Arch.</i> ,<br>John Minnema, <i>Bldr.</i> |
| " 7 Homes, Bayonne.....             | Golin Constr. Co., <i>Bldrs.</i>                              |
| " 20 Homes, Bayonne.....            | Stanley Builders                                              |
| " Sleep Shop, Paramus.....          | Lester Glass, <i>Bldr.</i>                                    |
| " El. School, Paramus.....          | A. Rigolo, <i>Arch.</i> , I. Degenars, <i>Bldr.</i>           |
| " Municipal Bldg., Moonachie.....   | Joseph Kindergan, <i>Bldrs.</i>                               |
| " Robert Hall Stores, New Brunswick |                                                               |
|                                     | Chuckrow & Wyckoff, <i>Bldrs.</i>                             |



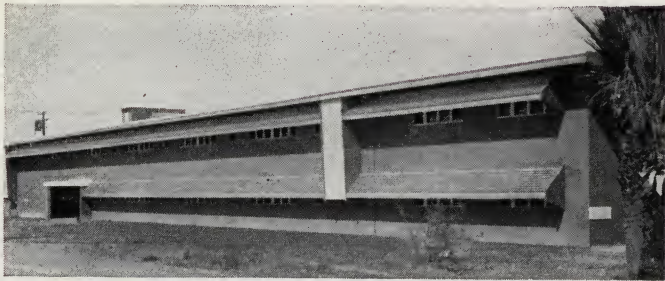
Bowlero, Bowling Alley, N. J. 1954  
Peter Holley, *architect*; Thomas Constr. Co., *builders*



Spring Valley School, Paramus, N. J. 1954  
Arthur Rigolo, *arch.*; I. Degenars, *bldrs.*



# SOME TYPICAL INFRA PROJECTS



ATOMIC ENERGY COMMISSION BUILDING

Salton Sea Testing Base, California

Kistner, Curtis, Wright, architects;

Triple Constr. Co., bldrs. General Insulation Co.

Photos of other Infra Insulated structures are classified material.



Techbuilt House

Nationally distributed prefabricated residence, 1954-1955

Karl Koch, architect; Techbuilt, Inc., bldrs.

H. S. MORGAN residence, Eatons Neck, L. I. Alex P. Morgan, *architect*. E. W. Howell Co., *builders*.

1000 HOUSES, Massapequa Park, L. I., 1950, 1951. Midland Housing, Inc., Alwyn Cassens, *architect*.

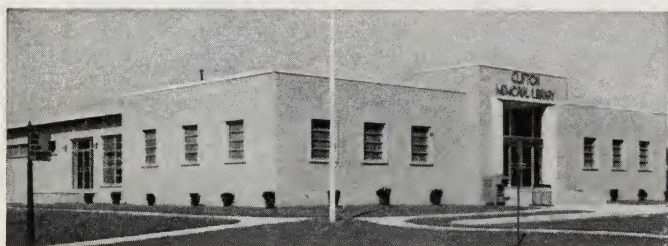
NEW YORK STATE COLLEGE OF AGRICULTURE, 1950. Horse Barn. Building designed and constructed by Dept. of Buildings and Grounds, CORNELL UNIVERSITY.

SIENA COLLEGE, Loudonville, Albany, N. Y. March 1950. Gander, Gander and Gander, *architects*. Wm. L. Crow Constr. Co., bldrs. Faculty Structure, Sacristy, etc. Steel truss insulation.

U. N. APARTMENT HOUSING, Great Neck, L. I. 1946. M. Exerjian, *architect*. S. Atlas, *builder*.

HOUSE & GARDEN MAGAZINE, Rye, N. Y., 1950 Model Home. Philip Ives, *architect*.

| PROJECT                                       | BUILDER, ARCHITECT, etc.                                       |
|-----------------------------------------------|----------------------------------------------------------------|
| N. J., 1st National Bank, Garfield.....       | L. Fellgraf, Arch.,<br>Muscarella Constr. Co., Bldrs.          |
| " St. Mary's Convent, Closter.....            | M. Geo. Vuinovich, Arch.,<br>Callahan Bros., Bldrs.            |
| " El. School, Closter.....                    | L. F. Fellgraf, Arch.,<br>Acme Eng. Maint. Co., Bldrs.         |
| " Res., Ridgefield.....                       | R. Cadien, Arch.,<br>Equitable Homes Inc., Bldrs.              |
| " Res., Ridgefield.....                       | S. John Setti, Arch., P. Leone, Bldr.                          |
| " Ass'n Films Inc., Ridgefield.....           | E. Kohlsaat, Bldrs.                                            |
| " Cameron Apts., Ridgewood.....               | N. Convery, Arch.,<br>C. S. Carlson, Bldr.                     |
| " Office Bldg., Ridgewood.....                | R. Novak, Arch., C. S. Carlson, Bldr.                          |
| " Courthouse, Freehold.....                   | J. Mancuso, Arch.,<br>B. J. Lucarelli Co., Bldrs.              |
| " El. School, Woodbridge.....                 | I. Davey, Arch.,<br>Randazzo Constr. Co., Bldrs.               |
| " Prudential Ins. Co., Woodbridge.....        | Gary Allstate Bldg. Co., Bldr.                                 |
| " Universal Corrugated Mach. Co., Linden      | Samworth-Hughes Co., Bldrs.                                    |
| " Commodore Embroidery Co., Fairview.....     | S. Pluchino Co., Bldrs.                                        |
| " Architect's Res., Woodcliff Lake.....       | Peter Butler, Arch.                                            |
| " Architect's Res., Short Hills.....          | James Centanni, Arch.                                          |
| " Cadwalader Park Homes, Trenton.....         | L. H. Kahan & Co., Bldrs.                                      |
| " Grand Union & Shopping Center, Midland Park | Thomas Constr. Co., Bldr.                                      |
| NEW MEXICO, 100 Homes, Albuquerque.....       | E. M. Chapman, Jr.                                             |
| " Natl. Bakery, Albuquerque.....              | Burwinkle & Springman, Arch.                                   |
| " 50 Homes, Albuquerque.....                  | C. A. Rutherford Jr., Bldr.,<br>Applicator, Bates-Cronican Co. |
| " Custer Res., Albuquerque.....               | R. C. Munro, Jr., Bldr.                                        |
| " Suttle Building, Albuquerque.....           | Ben Chazed, Bldr.                                              |
| " 25 Homes, Santa Fe.....                     | Hesselden Bldg. Co.                                            |



Clifton Memorial Library, Clifton, N. J. 1954  
James De Rose, architect; Colin Constr. Co., bldrs.

| PROJECT                                      | BUILDER, ARCHITECT, etc.                                            |
|----------------------------------------------|---------------------------------------------------------------------|
| NEW YORK, North Utica Housing Project, Utica | Anderson-Fischer Assoc., Bldrs., Kinne & Pennock, Arch.             |
| " Prefabricated Homes, McDonough.....        | Ivan R. Ford                                                        |
| " St. Andrews Convent, Rochester.....        | Jos. P. Flynn, Arch.,<br>John B. Luther & Sons, Bldr.               |
| " Summerville Tract, Rochester.....          | Jerome Woods, Arch.,<br>Bristol Construction Co., Bldr.             |
| " Aerobilt Bodies, Inc., Athens.....         | James Stewart & Co.                                                 |
| " Elmira Floral Products, Elmira.....        | Welliver Constr. Co., Bldr.,<br>Haskell, Considine & Haskell, Arch. |
| " Edward Lowe Res., Eastchester.....         | Lawrence M. Loeb, Arch.                                             |
| " 17 Res., New Rochelle.....                 | Asher Dann & Sons, Bldrs.                                           |
| " Bonny Crest Estates, New Rochelle, N. Y.   | Henry J. Moger, architect; Wykagyl Assoc., Inc., Bldrs.             |
| " Mech. Arts High School, New Rochelle.....  | L. H. Lyons, Arch.                                                  |
| " Model Home, New Rochelle.....              | Leland H. Lyon, Arch.                                               |
| " Joseph Cuzzi Res., Pelham Manor.....       | Cuzzi Bros. & Singer                                                |
| " Comm'l Decal. Factory, Mt. Vernon.....     | Cuzzi Bros. & Singer                                                |
| " Alpert Res., Mt. Vernon.....               | Blitman Construction Co.,<br>Arthur Peyser, Arch.                   |
| " Norman Homes, Mamaroneck.....              | Irving A. Lipsig                                                    |
| " Mohegan Park Dev., Yonkers.....            | Wm. Farrell                                                         |
| " Ackerman Res., Binghamton.....             | Sullivan & Lent, Applicator                                         |
| " F. J. Boland Res., Binghamton.....         | Sullivan & Lent, Applicator                                         |
| " J. Sufita Res., Binghamton.....            | Sullivan & Lent, Applicator                                         |
| " St. Mary's Church, Binghamton.....         | Vincent Smith, Inc., Contr.                                         |
| " L. W. Sullivan Res., Binghamton.....       | Sullivan & Lent, Applicator                                         |
| " John Merrill Res., Sidney.....             | C. J. Panaro, Contr.                                                |
| " Stonehouse Farms Res., Scarsdale.....      | Oscar A. DeBogdan, Arch.,<br>Delval Construction Corp.              |



Grand Union Shopping Center, Waldwick, N. J.  
Kenneth Higgins, architect; Paradise Co., bldrs.



# SOME TYPICAL INFRA PROJECTS



## OHIO STATE UNIVERSITY, COLUMBUS, OHIO

Hospital and Dental buildings, March 1950.

RADIANT CEILING HEATING. 400,000 sq. ft. Infra

Skidmore, Owings & Merrill, architects;

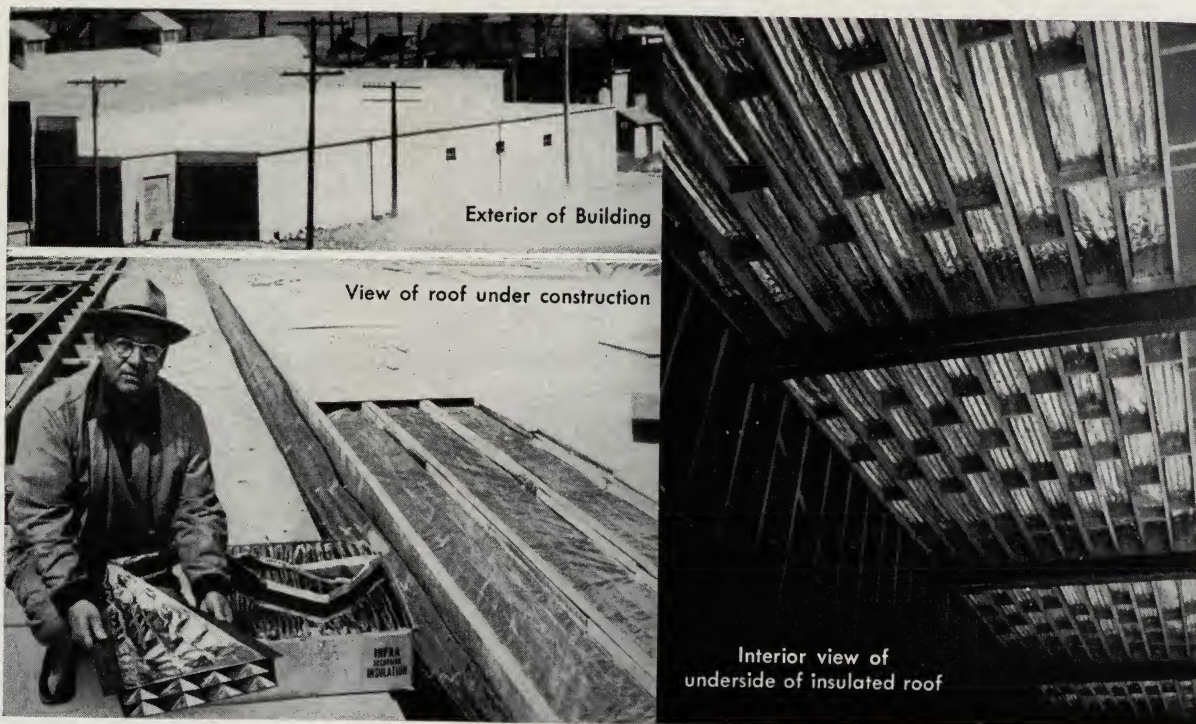
Grove, Drake & Psaty, general contractors.

| PROJECT                                             | BUILDER, ARCHITECT, etc.                                                                   |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------|
| NEW YORK, Wells College, Aurora.....                | J. F. Larson, Arch.,<br>Wm. E. Bouley Co., Bldrs.                                          |
| " Tappan Court Apartments, Tarrytown                |                                                                                            |
| " Irvington Estates, Irvington                      | Weymer H. Waite, Bldrs., N. O. Matson, Arch.<br>Alex Lipshitz, Bldr., H. I. Feldman, Arch. |
| " Rock Gate Farm, Bedford Hills                     | Holden, McLaughlin & Assoc., Arch.                                                         |
| " Garden Apartments, White Plains.....              | Block & Hesse, Arch.,<br>Hewett Builders, Inc., Bldrs.                                     |
| " Alanwood Corp., White Plains.....                 | Alan L. Carnoy                                                                             |
| " Shopping Center, White Plains.....                | Posner Constr. Co., Bldr.                                                                  |
| " Res., Greenberg.....                              | Oscar De Bogden, Arch.                                                                     |
| " Pierson Gardens, Ossining.....                    | H. I. Feldman, Arch.,<br>Anton Schnapp, Bldr.                                              |
| " Alger Court, Bronxville.....                      | D. B. Lawrence, Pres., Alger Constr.,<br>Joseph T. Sibley, Arch., Weymer Waite, Bldr.      |
| " Architect's Res., Nyack.....                      | G. M. Schofield, Arch.                                                                     |
| " Prof. D. Dropkin Res., Cornell University, Ithaca |                                                                                            |
| " Houghton College, Houghton.....                   | Everett Gilbert                                                                            |
| " 13 Dwellings at West Hill, Schenectady            | West Hill Engineering Group of General Electric Co.                                        |
| " 12 Dwellings, Scotia.....                         | Peter Sotile                                                                               |
| " Clyde Powell Res., Johnson City.....              | C. Powell, Applicator                                                                      |
| " Richard Powell Res., Johnson City.....            | R. Powell, Applicator                                                                      |
| " Architect's Res., Baldwinsville.....              | G. H. Ketcham, Arch.                                                                       |
| " Fayette Manor, Fayetteville.....                  | J. A. Cicci, Bldr.                                                                         |
| " 9 Houses, Syracuse.....                           | Harry D. Phoenix, Arch.                                                                    |
| " 6 Houses, Syracuse.....                           | Hawley E. McAfee, Arch.                                                                    |
| " First Trust & Deposit Co., Syracuse.....          | H. E. McAfee, Arch.,<br>Irish Construction Co., Contr.                                     |
| " Laventall Res., Albany.....                       | Henry L. Blatner, Arch.                                                                    |
| " Store Building, Albany.....                       | John Galvin, Arch.                                                                         |
| " Hoerdt Res., Albany.....                          | Gander, Gander & Gander, Arch.                                                             |
| " Residences, Albany.....                           | A. H. Ruth, Bldr.                                                                          |
| " Residences, Albany.....                           | Joseph F. Kusky, Bldr.                                                                     |
| " Apartment House, Albany.....                      | Shelley-Ruth Realty Co., Bldr.                                                             |
| " Apartment House, Albany.....                      | Jacob Freedman, Owner-Bldr.                                                                |
| " Tom Sawyer Motor Court, Albany.....               | Decker Constr. Co.                                                                         |
| " Town Tavern Cooler Room, Schenectady.....         | Modern Constr. Co.                                                                         |
| " Cement Mfg. Co., Howes Cave.....                  | No. Amer. Cement Co.                                                                       |
| " Plastic Curing Rooms, Athens.....                 | Imperial Lifeboat & Davit Co.                                                              |
| " Catskill High School, Catskill.....               | Henry L. Blatner, Arch.                                                                    |
| " Residences, Rensselaer.....                       | American Home Builders                                                                     |
| " Forman Res., Woodstock.....                       | Henry L. Blatner, Arch.                                                                    |
| " Cornell Mfg. Co.....                              | Eli Rabineau, Arch.                                                                        |
| " Farragut Gardens, Bklyn.....                      | Kavy & Kavovitt, Inc., Arch.                                                               |
| " Gus Pinelli, Bronx.....                           | Fred J. Ross, Arch.                                                                        |
| " Townsend Gardens, Bronx.....                      | A. Alkoff, Bldr.,<br>H. H. Lillian, Arch.                                                  |
| " Riverdale Gardens, Bronx.....                     | Seelig & Finkelstein, Arch.,<br>Charles Axelrod, Owner, Blitman Construction Corp.         |
| " Prospect Heights Apts., Staten Island.....        | Godfrey Weinstein                                                                          |
| " Butler Bros., Lumber, 201 St., N. Y. C.....       | J. Friedman                                                                                |
| " Riverdale Terrace, New York City.....             | Philip Birnbaum, Arch.                                                                     |
| " Apartment House, New York City.....               | I. L. Crausman, Arch.                                                                      |
| " State Unemployment Ins. Bldg., N. Y. City.....    | C. Lillian, Arch.                                                                          |

| PROJECT                                                         | BUILDER, ARCHITECT, etc.                                    |
|-----------------------------------------------------------------|-------------------------------------------------------------|
| NEW YORK, Forest Hills Apts., Forest Hills, L. I.               |                                                             |
| " P. Birnbaum, Arch., A. Kaskell, Bldr., Carol Management Corp. |                                                             |
| " George Washington Apts., Forest Hills, L. I.                  |                                                             |
| " Philip Birnbaum, Arch., Carol Management Corp.                |                                                             |
| " Architect's Res., Brookville, L. I.....                       | Wm. L. Bottomley, Arch.,<br>Stiles Building Corp., Bldr.    |
| " 17 Res., Hartsdale.....                                       | S. Paul, Arch., Hartsdale Lawns Inc., Bldr.                 |
| " Manhasset Church, Manhasset, L. I.....                        | Magoon & Salo, Arch.,<br>William L. Crow Construction Corp. |
| " Bee Builders, Inc., Astoria, L. I.....                        | Ben Hess                                                    |
| " Grade School, Nassau.....                                     | W. Parker Dodge Assoc., Arch.                               |
| " H. I. Pratt Res., Oyster Bay Cove, L. I.                      |                                                             |
| " E. W. Howell Co., Bldrs., Cuglor, Kimball & Huster, Arch.     |                                                             |
| " Northcrest Gardens Stores & Theatre, Flushing, L. I.          |                                                             |
| " S. Malkind, Arch., S. Bernstein, Bldr.                        |                                                             |
| " 4 Apartment Buildings, New York City                          |                                                             |
| " Greenberg & Ames, Arch., Weisner Constr. Co., Bldrs.          |                                                             |
| " Apartment House, New York City.....                           | Clarence Lillian, Arch.,<br>Mansten Constr. Co., Bldrs.     |
| " Beacon Hill Manor, Dobbs Ferry, N. Y.....                     | D. Kraus, Arch.,<br>M. P. During, Bldr.                     |
| N. DAK., 12 Residences, Fargo.....                              | Owen Bertelson, Contr.                                      |
| " Architect's Res., Fargo.....                                  | Edw. W. Staszko, Arch.                                      |
| " Catholic Church, Bottineau.....                               | G. N. Bugenhagen, Arch.                                     |
| OHIO, 200 House Project, Lima.....                              | Universal Heating, Inc.                                     |
| " St. Mary's Church, Olmsted Falls.....                         | R. S. Ursprung Constr. Co.                                  |
| " Res., Cincinnati.....                                         | Carl A. Strauss, Arch.                                      |
| " 30 Homes, S. Euclid.....                                      | DiCarlo Builders                                            |
| " 8 Homes, Chagrin Falls.....                                   | Henry C. R. Greime, Arch.                                   |
| " Third Church of God, Springfield.....                         | Wm. Yoder, Bldr.                                            |
| " 15 Houses, Springfield.....                                   | Smith Structures                                            |
| " 181 Homes, Green Rd., Cleveland.....                          | Marvin Helf                                                 |
| " 50 Homes, Maple Heights.....                                  | Marvin Helf                                                 |
| " 5 Houses, Tipp City.....                                      | R. E. Turner, Bldr.                                         |
| " 10 Houses, Yellow Springs.....                                | Porter Constr. Co.                                          |
| " 5 Houses, Farmersville.....                                   | Riegel & Sons, Bldr.                                        |
| " 7 Houses, Eaton.....                                          | Brubaker Bros., Bldr.                                       |
| " Furniture Store, Brookville.....                              | Dunkel & Sons                                               |
| " Concordia Lutheran Church, Dayton.....                        | B. G. Danis, Bldr.                                          |
| " 13 Houses, Dayton.....                                        | Wm. Viets, Bldr.                                            |
| " Kenilworth Drive, Akron.....                                  | J. E. Jansen                                                |
| " Dutch Folk Res., Akron.....                                   | Firestone & Cassidy, Arch.                                  |
| " D. G. Remple Res., Akron.....                                 | Firestone & Cassidy, Arch.                                  |
| " A. Lomelo Res., Akron.....                                    | Otis Krumroy & Son, Arch.                                   |
| " Firestone Tire & Rubber Co. Re-Tread Bldg., Akron             |                                                             |
|                                                                 | Firestone Engineers                                         |
| OKLA., Architect's Res., Oklahoma City.....                     | R. W. Vahlberg, Arch.                                       |
| " Clyde's Drive-in Grocery, Oklahoma City.....                  | Scovill & Sublett                                           |
| " Bernard S. Weiss Res., Meadowbrook                            |                                                             |
| PA., Llanarch Project, Del. County.....                         | Philip A. J. Ienni                                          |
| " Tioga Pipe & Supply Co., Phila.....                           | Arrow Constr. Co., Bldrs.                                   |
| " Builders Res., Phila.....                                     | Wm. Sterling, Bldr.                                         |
| " A & P Super Market, Phila.....                                | Herman Grossman, Bldr.                                      |
| " 12 Stores, Phila.....                                         | Isard-Risen Co.                                             |
| " Masland Duraleather Co., Philadelphia                         |                                                             |



# SOME TYPICAL INFRA PROJECTS



Exterior of Building

View of roof under construction

Interior view of underside of insulated roof

Bardin Bros. owners; Newhall Peach & Assoc., architects and designers.  
Insulation was installed in continuous 160 ft. lengths.

BUCKNELL UNIVERSITY, Lewisburg, Pa., LIBRARY. Jens F. Larson, *arch.*, Sordoni Construction Co., *contractor*  
PHILADELPHIA-BOULEVARD APTS. Jan. 1947. Metropolitan Life Ins. Co. project. Edward Pearl, *builder*.  
ALUMINUM CO. OF AMERICA HOUSING, 300 Units, Port Lavaca, Texas.  
ELECTRICALLY HEATED Kelly Residence, Ft. Worth, Tex., Evans Builders.

| PROJECT                                                                    | BUILDER, ARCHITECT, etc.                                                     |
|----------------------------------------------------------------------------|------------------------------------------------------------------------------|
| PA., Post Office, International Airport, Phila.....                        | J. J. Edelman                                                                |
| " High Park Homes, Hatboro.....                                            | Joyce Industries, Inc.                                                       |
| " St. Joseph In The Hills, Malvern.....                                    | John P. Cane, <i>Arch.</i> ,<br>John P. Donovan, <i>Bldr.</i>                |
| " Laurel Bend Homes, Bristol.....                                          | Bertram Rudy, <i>Bldr.</i>                                                   |
| " Apartment Building, Newton Square.....                                   | Leon Crane, <i>Bldr.</i>                                                     |
| " Res., Mont. Co.....                                                      | A. C. Brosner, <i>Arch.</i> , Guy Frogile, <i>Bldr.</i>                      |
| " Builders Res., Montgomery Co.....                                        | F. B. Wagner, Sr., <i>Bldr.</i>                                              |
| " Country Club Manor, York.....                                            | Morton Keast, <i>Arch.</i> ,<br>Estoclet, Inc., <i>Bldr.</i>                 |
| " York Coffee Co., York                                                    |                                                                              |
| " 100 Homes, Hickory Tree Heights, Lancaster                               |                                                                              |
| " D. S. Warfel, <i>Bldr.</i> , Coleman & Coleman, <i>Arch.</i>             |                                                                              |
| " Sheet Metal Works, Boyertown.....                                        | Albert W. Mercer                                                             |
| " Factory Building, Pottstown.....                                         | Rosemont Dress Co.                                                           |
| " L. Sweet Res., Quaker Lake.....                                          | Vincent Smith, Inc., <i>Contr.</i>                                           |
| R. I., International Braid Co., Providence.....                            | A. J. Puschin, <i>Engineer</i>                                               |
| S. D., St. Mary's School, Sioux Falls.....                                 | Harold Spitznagel, <i>Arch.</i>                                              |
| " Bellfourche Public School, Bellfourche.....                              | H. Spitznagel, <i>Arch.</i>                                                  |
| " R. E. Hubbard Res., Watertown.....                                       | H. Spitznagel, <i>Arch.</i>                                                  |
| " City Disposal Plant, Milbank.....                                        | Perkins & McWayne, <i>Arch.</i>                                              |
| TEXAS, Celanese Corp. of America, Clarkwood                                |                                                                              |
| " Kenneth Vaughn Res., Aberdeen.....                                       | Plant Engineer, <i>Arch.</i>                                                 |
| " School & Gymnasium, George West.....                                     | Steel Products, Inc.                                                         |
| " Davis Constr. Co., <i>Bldr.</i> ,<br>Wade, Gibson & Martin, <i>Arch.</i> |                                                                              |
| " Menger School Addition, Corpus Christi.....                              | E. E. Harrison, <i>Bldr.</i> ,<br>Wade, Gibson & Martin, <i>Arch.</i>        |
| " Fannin School, Corpus Christi.....                                       | Braselton Constr. Co., <i>Bldr.</i> ,<br>Wade, Gibson & Martin, <i>Arch.</i> |
| " Texas Highway Dept. Bldg., Corpus Christi                                |                                                                              |
| " O. J. Beck & Sons, <i>Bldr.</i> , Smyth & Smyth, <i>Arch.</i>            |                                                                              |
| " Sam Houston School Addition, Corpus Christi                              |                                                                              |
| " O. J. Beck & Sons, <i>Bldr.</i> , E. E. Hamon, <i>Arch.</i>              |                                                                              |
| " Architect's Res., Corpus Christi.....                                    | E. E. Hamon, <i>Arch.</i>                                                    |

| PROJECT                                                               | BUILDER, ARCHITECT, etc.                                                     |
|-----------------------------------------------------------------------|------------------------------------------------------------------------------|
| TEXAS, North Beach Elem. School, Corpus Christi                       |                                                                              |
| " Smyth & Smyth, <i>Arch.</i> , Hinchberger Constr. Co., <i>Bldr.</i> |                                                                              |
| " Elementary School Bldg., Agua Dulce.....                            | E. E. Hamon, <i>Arch.</i>                                                    |
| " Nueces County Bldg., Agua Dulce.....                                | L. A. Hanke, <i>Bldr.</i> ,<br>Wade, Gibson & Martin, <i>Arch.</i>           |
| " City-County Bldg., Bishop.....                                      | Wade, Gibson & Martin, <i>Arch.</i> ,<br>So. Texas Constr. Co., <i>Bldr.</i> |
| " 5 Houses, Sioux Falls.....                                          | O. H. Mahlstedt                                                              |
| " Christ the King Church, Sioux Falls.....                            | Schoening & Spritznagel                                                      |
| " Sheldon Reese Apts., Huron.....                                     | Acme Company, <i>Contr.</i>                                                  |
| " Jim Peterson Res., Mitchell.....                                    | Walter Dixon, <i>Arch.</i>                                                   |
| " Mission Residence, Mission.....                                     | C. Lyman Ellis & Co., <i>Arch.</i>                                           |
| " Bob Nordmeyer, Mission.....                                         | C. Lyman Ellis, Jr., <i>Arch.</i>                                            |
| " Furniture Store, Sulphur Springs.....                               | Tapp Furniture                                                               |
| " Central Baptist Church, Robstown.....                               | E. E. Hamon, <i>Arch.</i> ,<br>Ben T. Davis, <i>Bldrs.</i>                   |
| " Sales Bldg., Galveston.....                                         | Waples Lumber Co.                                                            |
| " McCarty Shopping Center, Ft. Worth                                  |                                                                              |
| " W. L. Kelly & Assoc., <i>Arch.</i>                                  |                                                                              |
| " Chicotsky Shopping Center, Ft. Worth.....                           | Herman G. Cox, <i>Arch.</i>                                                  |
| " Count B. Capps Res., Ft. Worth.....                                 | Preston M. Geren, <i>Arch.</i>                                               |
| " John W. Potter Res., Ft. Worth.....                                 | John W. Floore, <i>Arch.</i>                                                 |
| " Joe R. DeGrazier Res., Ft. Worth.....                               | Chas. E. Armstrong, <i>Arch.</i>                                             |
| " 8 Homes, Ft. Worth.....                                             | Jos. H. Gaylord & Co., <i>Arch.</i>                                          |
| " A. W. Stubbeman Res., Ft. Worth.....                                | W. F. Lytle & Sons, <i>Bldr.</i>                                             |
| " L. L. Songer Res., Ft. Worth.....                                   | McLure & Co., <i>Arch.</i>                                                   |
| " Fire Station, Dallas.....                                           | Hidell & Decker, <i>Arch.</i>                                                |
| " Laurel Motel Tourist Lodge, Dallas.....                             | Radco Constr. Co., <i>Contr.</i>                                             |
| " Apartment House, Dallas.....                                        | C. C. McLain, <i>Designer-Bldr.</i>                                          |
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| " Architect's Res., Dallas.....                                       | Ralph Merrill, <i>Arch.</i>                                                  |
| UTAH, Lundberg Buick Co., Logan.....                                  | Rocky Mt. Empire Co.                                                         |
| " Builders Service Co., Salt Lake City.....                           | Rocky Mt. Empire Co.                                                         |
| VERMONT, Montpelier Tavern.....                                       | Thomas Worcester Co., <i>Arch.</i> ,<br>W. S. Lane, <i>Contractor</i>        |
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# SOME TYPICAL INFRA PROJECTS



FRUIT COLD STORAGE  
Small Bros., Entiat, Wash.

Designed and refrigerated by Art de Desrochers. 26,000 sq. ft. Infra protects 30,000 boxes of apples.

## PROJECT

## BUILDER, ARCHITECT, etc.

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 " Fruit Storage, Homer Trefry, Wenatchee  
 " Padoshek Bldg., Wenatchee.....*Newhall Peach & Assoc., Archs.*  
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 " First Methodist Church Nave, Wenatchee.....*Joe Wood, Designer*  
 " Spinners Warehouse, Wenatchee  
 " Yellowstone Motel, Wenatchee  
 " Taplett Fruit Co., Wenatchee  
 " Fruit Storage, Arne Jensen, Wenatchee  
 " Fruit Storage, Ted Waterhouse, Orondo  
 " Fruit Storage, Leonard Zanol, Orondo  
 " Fruit Storage, James Whitbeck, Orondo  
 " Res., Montgomery Co.....*Di'Fulvio, Bldr.*  
 " Res., Abington.....*Price & Waelchli, Bldr.*  
 " Fruit Storage, Clark Bixler, Cashmere  
 " Fruit Storage, P. C. Burkey, Entiat  
 " Fruit Storage, Garretson Bros., Tieton  
 " Pepsi-Cola Co., Yakima.....*E. P. Erwen*  
 " Builder's Res., Yakima.....*E. P. Erwen*  
 " Washington Fruit & Produce, Yakima  
 " Richey & Gilbert Fruit Co., Yakima  
 " Kenyons Zero Storage, Grandview  
 " Rock Island School, Rock Island.....*Alvin Erickson, Arch.*  
 " Cashmere Medical Center, Cashmere.....*Alvin Erickson, Arch.*  
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 " St. Anthony's Rectory & Convent, Harlingen  
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- WISC., Milwaukee Engineering School.....*J. P. Cullen Co.*  
 " Prefabricated Homes, Janesville.....*Midwest Housing Corp.*  
 " Wesenberg Res., Portage  
 " McCullough Res., Portage  
 " Gerald Radant Res., Portage.....*Gerald Radant*  
 " M. E. Zuleger (Atty.) Res., Ackersville.....*M. E. Zuleger*  
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- WYOMING, Jos. Carey Res., Cheyenne.....*Edw. Hubbell, Arch.*



Hatchery, Parker's, Arlington, Texas

The installation of Infra caused a 10% increase in hatches and a 10 to 12 degree drop in building temperature.



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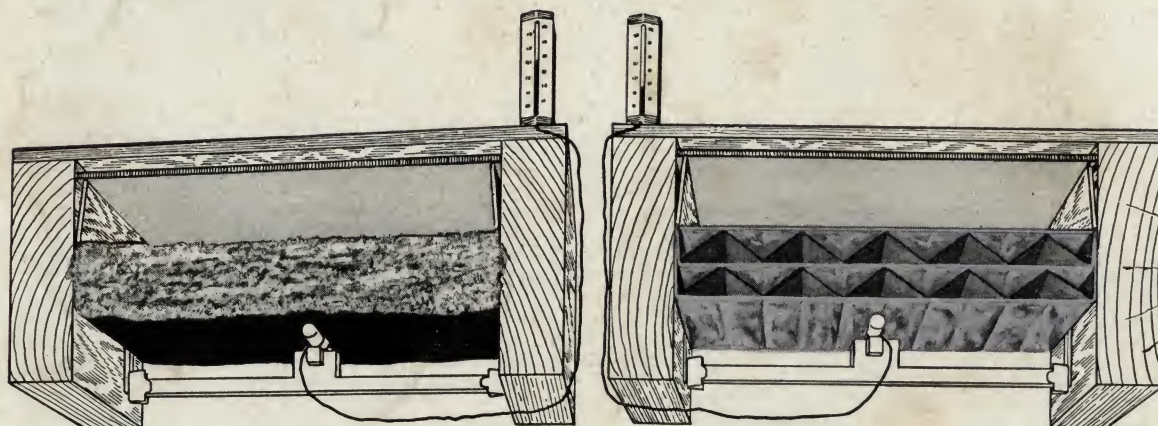
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## COMPARE THE VARIOUS THERMAL INSULATIONS!



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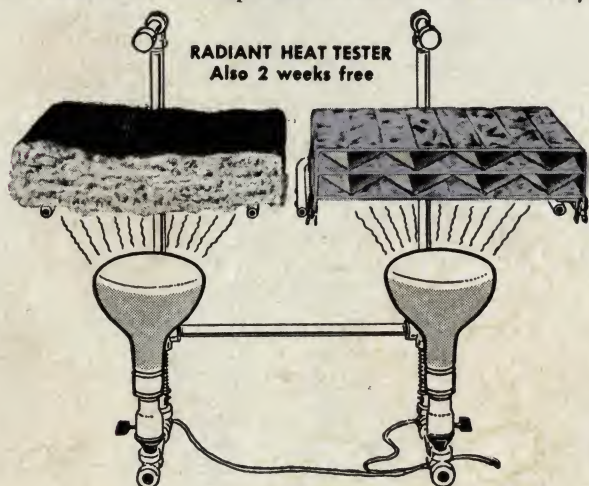
It is simple to use, lightweight, compact, and portable. It comes in 2 similar, interchangeable units, with 2 Taylor thermometers. But you can use your own thermometers and also your sense of touch. The device will simultaneously test and compare under similar conditions any two insulations of your own selection, for *up-heat, down-heat or wall-heat flow*.

You will also be able to test and compare the new, full depth, **EDGE-TO-EDGE** multiple accordion aluminum insulation which we will send you **FREE**. Its multiple aluminum and fibre sheets drastically reduce outer and inner **CONVECTION**. Its multiple spaces of low-density air are very poor **CONDUCTORS**. Its multiple aluminum surfaces resist **RADIATION** or heat rays with 97% reflectivity, and 3% absorptivity and emissivity. (In addition, its permeability to water vapor is almost zero. Infiltration under the flat, stapled flanges is slight. Condensation-formation is minimized on or within this scientific construction of multiple air spaces, accordion fibre, and layers of edge-to-edge aluminum.)

Of course the *best test* of an insulation is **USE** — actual, practical, day to day, year after year performance in buildings — the record of savings in fuel — comfort, winter and summer. **More than 300 MILLION SQ. FT. of Infra Multiple aluminum insulation have been installed, a good deal of it repeat orders.**

The next best test is a laboratory test.

But you can also make some interesting and illuminating tests of your own, in the privacy and convenience of your office, by mailing the coupon.



Infra Insulation, Inc., 525 B'way, N.Y.C. Dept. (MM)  
Please send for 2 weeks free use without my assuming responsibility for damage to devices:

☐ Joist Space Heat Tester ☐ Radiation Tester

Name \_\_\_\_\_

Firm \_\_\_\_\_

Nature of Business \_\_\_\_\_

Address \_\_\_\_\_

*Offer of testers limited to the building industries and associated fields. Please attach coupon to your letterhead.*



# Make Your Own Tests!

## COMPARE THE VARIOUS THERMAL INSULATIONS!



Digitized by



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FOR  
PRESERVATION  
TECHNOLOGY,  
INTERNATIONAL

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From the collection of:

Mike Jackson, FAIA

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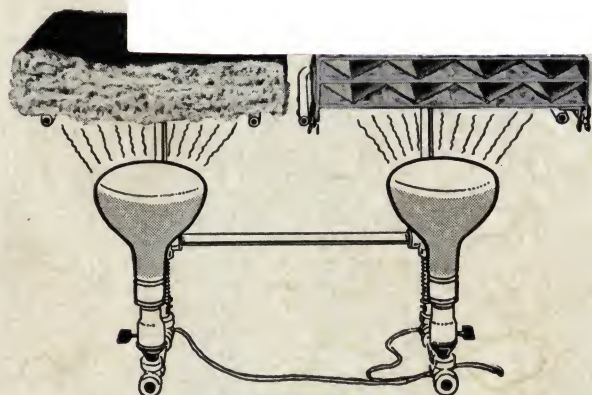
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☐ Joist Space Heat Tester

☐ Radiation Tester

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Offer of testers limited to the building industries and asso-  
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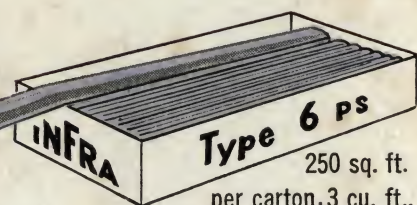
# HEAT FLOW BY **RADIATION** IN BUILDINGS

## SIMPLIFIED PHYSICS

by Alexander Schwartz, president, Infra Insulation Inc.

### MULTIPLE ACCORDION ALUMINUM

Full, uniform depth from joist-to-joist.\*  
Practically non-condensation forming.  
Storage space and handling drastically reduced.  
Low cost, lower fuel bills. More installed per man.  
Clean and sanitary. Does not retain odors.  
Lengths: 750', 500', 375', 188'.



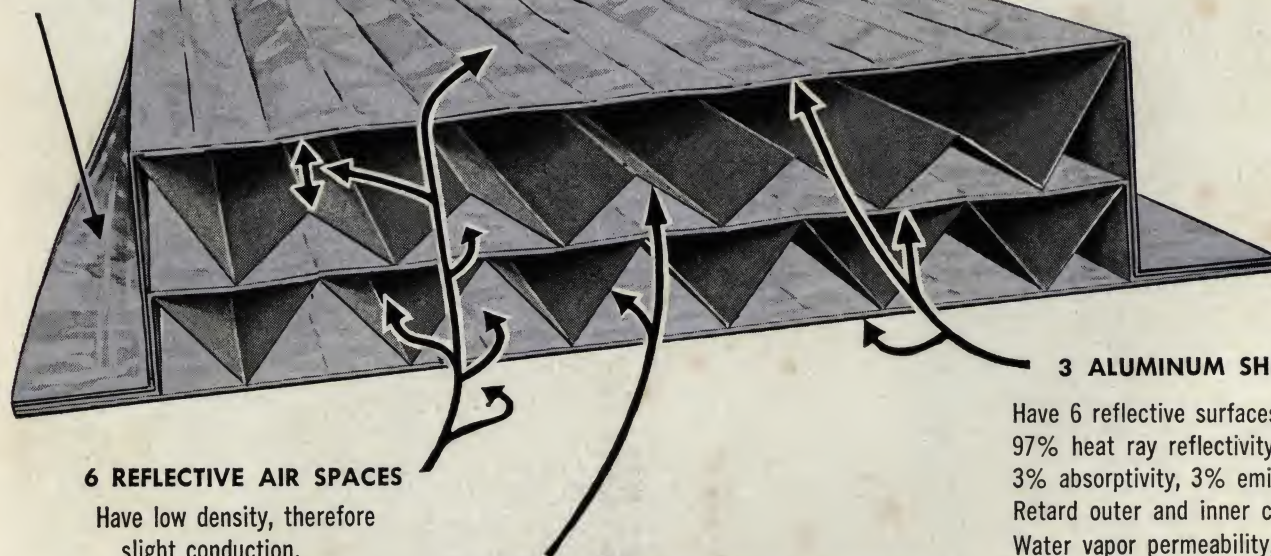
250 sq. ft.  
per carton, 3 cu. ft., 34 lbs.

(Ordinary insulation)  
(43 cu. ft., 250 lbs.)

## INFRA

*the Scientific Insulation*

STAPLING  
FLANGE



### 6 REFLECTIVE AIR SPACES

Have low density, therefore  
slight conduction.  
2 outer reflective spaces.  
4 rows of inner air spaces.  
Space above pleats 1" extra.

### ACCORDION SEPARATING PARTITIONS

Create 2 extra reflective spaces.  
Retard inner convection currents.  
Prevent aluminum touching aluminum.  
Available flame, mold, insect-resistant.  
Available with asbestos.

### 3 ALUMINUM SHEETS

Have 6 reflective surfaces each with  
97% heat ray reflectivity, and  
3% absorptivity, 3% emissivity.  
Retard outer and inner convection.  
Water vapor permeability, almost zero.  
1220° F. melting point.  
Permanent. Tough, special aluminum.  
Will not deteriorate. 99.4% pure.

### COST OF INFRA INSTALLED

in new construction between  
wood joists, material with labor.

Type 6PS about 10¢ sq. ft.  
Type 4PS about 8¢ sq. ft.

*Conserves winter fuel-  
promotes summer coolness*

(U. S. Patent Nos. 1,757,479; 1,890,418; 1,934,174; 2,015,817; 2,101,856.)

\*Patent applied for.